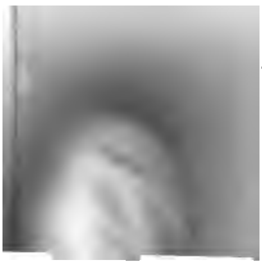
THE

VOLUNTEER RIFLEMAN

AND THE

RIFLE.

J. BOUCHER.




B. Clayton

THE VOLUNTEER RIFLEMAN

AND THE

RIFLE.

IN THREE PARTS:

SCIENCE, PRACTICE, AND THE MECHANICAL AIDS.

By JOHN BOUCHER,

MAJOR-COMMANDANT OF THE FIRST SURREY OR SOUTH-LONDON
RIFLE BATTALION,
AND
THE FIRST DIVISION OF THE VOLUNTEER FORCE OF THE COUNTY OF SURREY.
FORMERLY OF THE 5TH DRAGOON GUARDS.
AUTHOR OF "RIFLE PRACTICE," "RIFLE PROJECTILES," &C.

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SOUTH LONDON.

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ADJUTANT-GENERAL TO HER MAJESTY'S FORCES,

&c. &c. &c.

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PREFACE.

The First Edition of "The Volunteer Rifleman and the Rifle" was written in 1853, to aid the Volunteer movement of that period. The favourable reception it then met with has induced the Author to publish a Second, and now a Third Edition, enlarged and specially adapted to the movement of the present day.

The First Part contains no theory but what has been confirmed by careful and laborious practical experiments. The correctness of the Second Part is vouched for by HORSE GUARDS authority. A knowledge of the Third Part is necessary to all who would turn the First and Second to advantage. A careful and practical study of the whole will soon enable the Volunteer to say whether the Work is what it professes to be, namely, a plain but honest adviser of all who desire to become skilful and expert RIFLEMEN.

INTRODUCTION.

A GENERAL KNOWLEDGE AND PROFICIENCY IN THE USE OF FIRE-ARMS, THE BEST NATIONAL DEFENCE.

WAR is the endemical disease of nations. It is old as the history of the human race; and until the culture of mankind attains to such perfection as to admit of the creation of a supreme tribunal vested with the power to judge and decide between nations, or rather upon their differences and quarrels, wars will ever arise, and armies be raised and maintained.

In vain have the greatest philosophers, philanthropists, and historians, reproached princes and rulers with their misplaced ambition and blindness for plunging into war, on the most vain, frivolous, and unjust pretences. For upwards of ten centuries the divine inculcations of the Christian Faith have proved powerless to restrain the aggressive spirit of mankind. In vain when exhausted with their destructive contests, have sovereigns and states endeavoured to re-establish a secure and lasting peace' and every device of the statesman, in the framing of the most seemingly auspicious treaties, have proved fallacious and impotent to avert the recurrence of war.

Every attempt, in ancient and modern times, to constitute a system of polity for the avoidance of war has proved abortive. From the recorded origin of power, as traced throughout the whole history of mankind, justice has scarcely ever had any share in

its establishment; nor to this day of boasted civilization, does it find more respect as between nations than as between individuals What the mighty will of the Maker of all, may yet work out in the lapse of time, upon the human race, is for no man to measure or to say. But until a perfect unanimity of intelligence of the public right be developed throughout the nations of the earth, into one common resolve to deal out reciprocal justice to each other, there can be no hope of enduring peace.

To effect this, how distant is the hope, while the individual and personal jealousies, the mean animosities, the unjust hatreds, the cruel wrongs, which hourly exhibit themselves in the bosom of society—in the daily intercourse of life—the indulgence of which is scarcely restrained by the terror of the laws framed for its government.

When these shall be first corrected and cease, in the state of society called the *civilized world,* then will peace be permanent among nations of different languages, religions, customs, and laws. Then will war cease between nations, as between individuals; the open hostility like the private injury cease to consume its equal hecatombs; then will the agent of police as well as the soldier be no longer necessary—the minister of religion have no further office—the minister of the law, no one more to curb or to chastise.

In the meantime unlooked-for events have declared to us, that we know not what a day or an hour may bring forth. We have seen that from peace to war is but the work of a day. In one instant there may be a bright and a burning sun: the next a lurid and a blood-shot sky. Whether the storm which has lately raged over Northern Italy will ever reach our own shores may be still uncertain; but there it has been, in all its horrid reality. The whole sky has been darkened, and thunder clouds do not follow the wind, or any known law. No peaceful determinations, no formula of neutrality, not the most unaffected aspirations for peace, will avert war from our shores if certain contingencies should arise which have arisen before.

The possibility of an enemy being able to land an imposing

force, on some part of our coast, is admitted by the most distinguished authorities in every branch of the public service; for since the introduction of steam, "it is impossible for any navy, however active, vigorous, and numerous, to prevent altogether the landing of hostile troops," To prevent the concentration of our regular forces to resist the main attack, "the landing would doubtless be attempted simultaneously at two or three different points, and those points and the enemy's plan of attack could not be definitely known until he actually began to disembark his troops." If the attempt were made, it is also admitted, "that it would be with all his resources; he would omit nothing which could in any way promote the success of the undertaking, and would be quite as confident of the result, as we should be of driving him back into the sea."

That the enemy would be ultimately compelled to an unconditional surrender, or be driven head-long into the sea, we will not allow ourselves to doubt; but, supposing that, for want of a sufficient opposing force at the first, he was permitted to advance any distance into the interior—who shall tell of the havoc that would be caused, the attrocities that would be perpetrated, the cost of blood and life, before such a result could be accomplished?

At the commencement of the present century, when our country was threatened with invasion, and the powers of steam were unknown, the military force in England consisted of 184,000 regulars and militia, and no less than 400,000 volunteers, organized and ready to meet the enemy. Compared with this, what does our present force amount to? It is admitted that there is no danger if we are bold *and prepared to meet it*, but that we *are in danger* if we are *not* prepared. The question then is, are we properly prepared, or are outward appearances sufficient to lull us into apathetic security? Our authorities have spoken out, and the nation, almost as one man, has responded to the call. "Come who may, they will find but one heart and one spirit in these Islands—a spirit which had better not be meddled with! It is

true, that a nerveless, un-English voice may here and there be heard to say, "abstain from stimulating warlike passions at home, as this will be sure to excite suspicion and animosity abroad!" But which is the best way of preserving peace? Every right thinking man values its countless blessings, but these cannot be long enjoyed, whilst so little of the angelic nature exists in this sublunary scene, unless their possessors demonstrate that they will not, *without strong opposition*, allow their privileges to be invaded.

The cant phrase with those who sneer at the idea of preparing for danger in the time of peace, is that, in the event of an invasion taking place, "England would rise as one man." But this is simply absurd, for what would be the use of a *half armed undisciplined* rabble, such as could be got together on a sudden emergency? The great mass know no more about a gun than they do of the working of a steam engine, and, if intrusted with arms, would be much more likely to cause destruction among their friends, than injury to their foes. Of the hundreds of thousands in England, few of them have ever handled a musket, fewer still have ever fired a ball, or have even seen a ball cartridge. Is this a population to be suddenly called into the field and opposed to the fire of trained soldiers? Are these the intrepid and skilful hands that are to "drive the enemy into the sea," or "find for every invader a bullet and a grave?"

The fact is, that England, as a nation, cannot spring full armed into the arena of the battle field. "Peasants and Burghers, however brave," says Lord Macaulay, "are unable to stand their ground against soldiers, whose whole life has been a preparation for the day of battle; whose nerves have been braced by long familiarity with danger, and whose movements have all the precision of clock work." Yet these very men who, from their childhood, have lived a life of peace and quietness at home "buying or selling, or tilling their broad acres," possess the individual bravery and physical strength of disciplined troops, and only require to be trained and accustomed to arms, in order to place England in a position to

defy invasion; for as it has been justly remarked, "there is no fortification like brave men, armed, organized, and ready to meet an enemy; that is the best fortification, and such a fortification will always be found in the hearts and arms of Englishmen."

I may ask,is there a man, who, in the event of an invasion, would like to be unarmed and untrained? Is there one who would like to find himself unable to do anything to save his country and his relatives from injury and dishonour? He might *then* offer his services as a volunteer, but what would they be worth? Could he even be sure of obtaining a weapon? Three or four hundred thousand of his countrymen would be equally clamourous to be supplied, and with as good a chance of success as himself, for arms are not made in a week, or even in a month. But suppose him fortunate enough to obtain a rifle, what could he know of its use, or how to act in disciplined concert with others; for it takes a considerable time to make a thorough rifleman, whatever may be said to the contrary. Ought he, then, in the hour of his country's danger, to be just *beginning* to learn the means of defending her? Ought he, when she would be in need of his utmost skill and courage, to be taking his *first lessons* in drill?

In many parts of the continent of Europe, and in America, the inhabitants are accustomed to the use of arms from their youth. Why should this not be so in England? The spirit of the Briton is not yet on the wane, nor will his prowess fail when the sound of the trumpet is heard. Our forefathers were celebrated for their skill in the use of the English long-bow, why should not their descendants be as celebrated for their skill in the use of the *English* long-range rifle? If the rifle once becomes to England what the bow has been, a great step will have been made towards the attainment of national security, for national defence in other countries has always been promoted by a national habit of rifle shooting, and a love of fire-arms. In the Tyrol and Switzerland, rifle-shooting is a popular amusement. All above the labouring class have their rifles, and they weekly repair in little bands to some chosen glen; their practice ground. The targets are placed against the declivity, and

trenches are dug in front, where the markers lie sheltered, with long rods tipped with red, to point where the ball has struck. The marksmen retire to the opposite side of the dell. A puff of sudden smoke is seen, and the report of a rifle, followed by the *clack* of the struck target, rings down the ravine, another and another, succeeds the shout of exultation and merriment is borne upon the breeze until the vale grows dark, and the snowy mountain tops are reddened by the setting sun. Whole cantons meet on certain days of the year for the trial of their skill; twenty or thirty targets are set up, each with its knot of marksmen, and prizes reward the best shots. This is not only a popular amusement, but a useful one, for these riflemen are all enrolled in volunteer corps, and at stated times are drilled in military exercises, which enable them to turn out when wanted, in the defence of their country. In the wars with revolutionary and Imperial France, the Tyrolese corps did signal service to their country. The Tyrolese war in 1809, is one of the brightest pages of history. Without assistance from regular troops, they for months maintained their fastnesses against the united power of Bavaria and France, when the rest of Europe lay prostrate before the armies of Napoleon. "This," says Sir A. Alison, "was in a great degree owing to their extraordinary perfection in the use of fire-arms."

We, compared with other countries, should admit of no inferiority, for if, in every Town and Village of our native land encouragement were given, by the more wealthy inhabitants, to the formation of Rifle Associations, and the use of the rifle, a spirit of emulation would be created which would eventually lead to our rivaling the celebrated riflemen of the continent in their national amusement, for confidence in the rifle, and a knowledge of its powers, can only be gained by constant observation and practice. If this knowledge were once acquired, it would impart a feeling of security to those who possessed it, more especially if those persons were taught to feel that their safety, in a great measure, depended upon their own intelligence and individual prowess, and on the knowledge that the weapons they carried would if properly used,

bring an enemy to the ground at every shot. It would also impart a feeling of security to the aged and helpless inhabitants of those neighbourhoods in which such knowledge existed. There would then be no panics—no fear of invasion.

For Volunteers, the rifle service is not only the most effective, and the best adapted, but by far the most pleasant. It unfits the citizen for no duty, while it imparts to him the pleasing satisfaction of knowing that, in his own person, he can join in the defence of his Queen, his Country, and her Institutions. He will also become a better soldier, if he can make his military training a delight; if he can make his rifle practice an amusement; for "a useful thing is all the better for being a pleasure." He will try to perfect himself in shooting, he will take a pride in his rifle, and become attached to his comrades. Far from sighing for the completion of his term of service, he will sigh when, by advancing years, he is compelled to lay aside his rifle, and bid adieu to those in whose company he has spent so many pleasant and profitable hours.

In conclusion:—though there may appear at present no signs of any immediate aggression by an invasion of England, it does not become us to be apathetic on the subject. Deprived so lately and unexpectedly of the blessings of peace abroad, it is more than ever our duty to strengthen our defences at home. Sacred as our soil has been for centuries from the touch of an invader, we know not how long it may be spared the havoc and suffering that others have endured. We, as a nation, know nothing of the horrors of war, and are, therefore, but too apt to think little about it, or to be sufficiently thankful that our lot has been cast in so highly favoured a land.

CONTENTS.

Chapter IV.

On the Selection of a Rifle, or giving an order for one to be made.

Chapter V.

On Loading, Presenting, and Taking Aim.

Chapter VI.

Remarks on Loading, &c., continued.

Chapter VII.

Causes of Irregular Firing.

Chapter VIII.

On General Practice.

PART II.

CHAPTER I.

ON RECRUIT OR SQUAD DRILL.

CHAPTER II.

ON THE MANUAL EXERCISE.

CHAPTER III.

ON COMPANY DRILL.

CHAPTER IV.

LIGHT INFANTRY MOVEMENTS.

PART III.

CHAPTER I.

ON CLEANING THE RIFLE.

CHAPTER II.

ON CASTING BULLETS.

CHAPTER III.

ON VOLUNTEER EQUIPMENT.

APPENDIX.

LECTURES DELIVERED AT THE UNITED SERVICE INSTITUTION, AND WILLIS'S ROOMS, ST. JAMES'S.

I.

On the Rise and Progress of the "Minie Expansion" system, and the mistaken notions which it has unhappily engendered. Including Remarks on the Rifle Projectiles of different countries.

FIELD-MARSHAL

HIS ROYAL HIGHNESS THE PRINCE CONSORT, K.G.

&c. &c. &c.

IN THE CHAIR.

II.

On the comparative merits of the Rifled Small Arms of England, France, and the United States; with Remarks on the various modes of grooving Rifle Barrels.

VICE-ADMIRAL

HIS GRACE THE DUKE OF NORTHUMBERLAND, K.G.

&c. &c. &c

IN THE CHAIR.

III.

On the falsity of the Principles on which the present service Wood-Plug Ammunition is constructed. With Illustrations and Experimental Proofs.

COLONEL W. H. SYKES, M.P., F.R.S.

&c. &c. &c.

IN THE CHAIR.

PART I.

CHAPTER I.

DEFINITIONS AND EXPLANATIONS OF CERTAIN TERMS, AS APPLIED TO RIFLE PROJECTILES AND THEIR MOTION.

Action and Re-action.—Atmosphere.—Body.—Density.—Force. —Friction.—Gravity.—Centre of Gravity.—Specific Gravity. —Inertia.—Maximum and Minimum.—Momentum.—Motion. —Rest.—Vacuum.—Velocity.—Initial Velocity.—Remaining Velocity.

A BULLET, on leaving the muzzle of any firearm, whether it has a smooth bore or a rifled barrel, makes a passage more or less short through the air before it reaches the mark. During the whole time of its flight it is subjected to certain influences quite independent of the nature of the barrel from which it is projected; and these influences it is necessary to study in the first place, as we must take them into calculation in our method of using the rifle.

Before proceeding, however, to the consideration of these influences, it is deemed advisable to explain the meaning of certain technical terms that will be

used, as the knowledge of them is indespensible to the right comprehension of the subject. Definitions, however, when enlarged upon, often draw us into metaphysical subtleties and distinctions, which, whatever be their merit or importance, would be here altogether misplaced. I shall, therefore, confine myself to such explanations only as have reference to the subject matter in question.

Action and Re-action.—Action is that motion which one body produces, or endeavours to produce, in another. In *gunnery*, the charge of gunpowder on expansion acts upon the gun and shot with equal power, of which the *recoil* of the one and the *range* of the other are familiar examples. In each of these cases the impulse is counteracted by what is termed the Re-action; and that "Action and Re-action are always equal" is not only laid down as an axiom in mechanics, but is understood to be a general law of nature. But to explain more fully, the elastic fluid generated on combustion is re-ácted upon by the bullet, and the rifle is forced to recoil with considerable momentum; but with a rifle light in proportion to the weight of the bullet, the velocity of its recoil increases, and is violent in proportion to its lightness. As action and re-action are always equal, and in contrary directions, whatever momentum the rifle gains one way by the stroke, the bullet loses as much in the other way, and so shortens its range. A bullet that passes through the barrel with little *friction*, will range *further* with *less* recoil.

Atmosphere, is the enormous mass of air in which we live and breathe. It is an invisible *elastic* fluid, and surrounds our globe far beyond the summits of the highest mountains. It can be compressed into a much less space than that which it naturally possesses. The oxygen which it contains especially promotes the combustion of gunpowder, &c. Fire is active in proportion to the combustibility of the substances on which it acts, and to the quantity of atmospheric air which is afforded to it; a due quantity of air has, therefore, more to do with the proper effect of gunpowder than many are aware of. The atmosphere possesses the capacity of absorbing and sustaining moisture, and this, by rendering the atmosphere denser, more or less, affects the flight of the bullet. A great number of facts prove the existence and materiality of the air, its weight, resistance, &c. Its resistance to the flight of a bullet is in proportion to the square of the velocity, until a certain rate of motion is attained; for example: a velocity of 200 feet per second causes a resistance four times greater than a velocity of 100 feet per second; a velocity of 300 feet per second causes a resistance nine times greater than a velocity of 100 feet per second, and so on, so that, by increasing the velocity of a bullet through the air, we must increase the propelling power in a greater proportion, in order to compensate the loss caused by the air's resistance.

Body, is the mass or quantity of matter in motion, or to be put in motion, or acted on. By

the *mass* or actual volume of a body is understood the quantity of material parts of which it is composed. The material parts are particles separated from one another by spaces termed pores. In proportion to the largeness or smallness of the pores, is the weakness or strength of a rifle barrel. A body that yields to pressure, and recovers its figure again, is called an *elastic* body; and one that will not do so, is named a *non-elastic* body. The gases that are generated by the combustion of gunpowder are elastic bodies; the atmosphere is also an elastic body. Lead is a non-elastic body, and, from its density and softness, is peculiarly adapted for rifle bullets.

DENSITY, is the proportion of the quantity of matter in any body, to the quantity of matter in another body of the same size. A body which, from its closeness of texture, or compactness, contains more matter than another, under the same bulk, is said to be denser than the other, and that in proportion to the quantity of material elements which it contains. A leaden bullet is denser than an iron one, because a cubic inch of lead weighs more than a cubic inch of iron. The temperature has an influence on the density of the air; when it rises, the air dilates, its density diminishes, and the resistance it opposes to a bullet becomes weaker; when the temperature is lowered, the density of the air increases, and its resistance to the bullet is greater, Every change in the temperature, by varying the density of the air, changes the form of the trajectory,

or path of the bullet, as it offers a lesser or greater resistance to the bullet in its flight, and, consequently, lengthens or shortens its range. When the air is dense, the aim must be higher, in order to hit the same mark.

FORCE, is a power exerted on a body to move it. The forces that engage our attention are those which have the property of impelling inanimate objects from a state of rest to a state of motion, of stopping them when in motion, or of altering the character of their motion. Forces are *instantaneous* or *continued;* the former is an impulse, like the stroke of the hammer of a lock upon the cap; the latter acts without intermission, like pressure. The gases generated by the explosion of the gunpowder act with an accumulating *pressure* against the bullet in the barrel, and communicates velocity to it. *Forces* are also distinguished into *motive*, and *accelerating* or *retarding*. The *motive* or moving force relates to the quantity of matter moved as well as the velocity communicated by the gunpowder, and is proportional to the momentum or quantity of motion produced in a given time. An *accelerating* or *retarding* force is commonly understood to be that which affects the velocity only. The force of gravity *accelerates* the fall of the bullet: the accumulation of the gases of the fired gunpowder *accelerates* the motion of the bullet through the barrel: the resistance of the air *retards* its onward progress, until the force of gravity draws it to the ground.

FRICTION, is a retarding force, arising from the parts of one body rubbing against the parts of another. A bullet is more or less retarded in its velocity by *friction ;* in the first place, by its friction on the sides of the barrel, and in the next place by the friction of the air, independent of its opposing force. This effect is produced by inequalities of surface, as in every case, there is, to a lesser or greater degree, a roughness or unevenness of the surface, arising from a difference in form, and other causes, and, therefore, when the two bodies come together, the prominent parts of the one rub against the other, so that the *progressive* motion of the bullet is retarded, and often driven out of the straight line.

In the barrel, the friction of the bullet will be greatly diminished by lubricating the rubbing surfaces with a greasy substance, for it acts as a polish by filling up the cavities of the rubbing surface, and thus makes the one slide more easily over the other. In the air, the friction, and any tendency to be forced aside, will be greatly diminished by having the surface of the bullet made as smooth and perfect as possible; for an elongated rifle bullet does not *roll* like a spherical ball projected from a smooth bore, but *slides* through the air, with a spiral motion, dragged as it were by the force of its own momentum.

GRAVITY, is a name given to that tendency which bodies have to fall to the earth, or rather towards its centre. *Gravity* and *attraction* are often used synonymously; both being abstract names for

the same unknown power. Bodies falling directly downwards fall quicker and quicker as they descend. A bullet in its flight has this *falling* motion as well as a *progressive* one.

The velocity of a falling body is uniformly accelerated in its approach towards the ground, *if the resistance of the atmosphere be not taken into account,* and this acceleration takes place in regular arithmetical progression, as follows:—a dense or compact body, like a leaden bullet, when falling *freely*, passes through a space of $16\frac{1}{12}$ feet during the first second of time; during the first two seconds, it falls through four times as much as the first, or $64\frac{1}{3}$ feet; during the first three seconds, it falls through nine times as much as the first, or $144\frac{3}{4}$ feet, and so on, taking the square of the number of seconds; that is, the number multiplied by itself, in proportion, as 1, 4, 9, 16, &c.

This motion being a *uniformly* accelerated one, a fraction of a second may also be taken, that is, if in one fraction of a second the bullet falls a certain space, at the end of the two first fractions it will have fallen a space equal to four times the first; at the end of the three first fractions, it will have fallen a space equal to nine times the first, and so on, the degree or quantity of velocity being always proportioned to the length of the time; for gravity acts during the whole movement, and constantly adds a new action to all the actions already produced. The action of gravity being constant, the shape of the curve, or trajectory of the bullet, must

depend on its velocity, as projectile force does not in the least interfere with the force of gravity. A bullet flying horizontally at the rate of 2000 feet per second, is attracted downwards with precisely the same force as one flying at the rate of 1000 feet per second, and must therefore descend the same distance in the same time. From this it will be seen, that the distance to which a bullet will go, depends on the force of impulse given to it the first instant, its projectile velocity. If it move slowly, the distance will be short; if more rapidly, the space passed over will be greater.

Centre of Gravity, is a point in a body from which, if that body could be suspended, the whole body would remain at rest, in whatever respective position the surrounding parts may be turned. Every solid body, or dense mass, possesses a centre of gravity, that is, a point upon or about which the body balances itself, and remains in a state of rest or equilibrium in any position. In regular shaped bodies, this centre is in their middle part. In irregular-shaped bodies it is that point about which all the parts exactly balance each other, in every position of the body; if, therefore, that point is supported, the body will not fall. An elongated bullet is an irregular-shaped body, and will range further and more steadily, if the centre of gravity is thrown well forward, so as to counteract the resistance and friction of the air, which is apt to to make it move with an irregular motion, or even to turn it aside when the centre of gravity is too

far back; that point, in all projectiles, being *naturally* inclined to go foremost.

SPECIFIC GRAVITY, is the comparative weights of bodies under equal bulk. In this sense a body is said to be specifically heavier than another, when under the same bulk it contains a greater weight than that other; and reciprocally, the latter is said to be specifically lighter than the former. Thus, if there be two equal spheres, each one foot or one inch in diameter, the one of lead and the other of iron; since the leaden one is found heavier than the iron one, it is said to be specifically, or in specie, heavier: and the iron one specifically lighter. Leaden bullets being specifically heavier than iron ones, range further; as, under the same *bulk*, they have more *weight*, and are thus better calculated to overcome the resistance of the air.

INERTIA, means passiveness or inactivity. By the inertia of matter is understood the impossibility of bodies changing their condition of motion or rest without the aid of a particular cause which acts upon them at the instant when they change their condition. Thus, matter is perfectly passive in submitting to any condition in which it is placid, whether of rest or motion. When at rest, it shows an inability to move; and when in motion, it shows an equal inability to come to a state of rest; in the former case the slightest force which solicits it to move, if not opposed by an equivalent force, is obeyed; in the latter case the slightest obstacle

which retards it, takes away something from its velocity; and, if such action continue, will finally extinguish the whole motion. Thus, the continued resistance of the air enables the force of gravity to bring a bullet to the ground, at a lesser or greater range, according to the velocity acquired by the force which moved it.

If one body, as a leaden ball, contains twice or thrice as much matter as another body, as an iron shell, it will have twice or thrice as much inactivity; that is, it will require twice or thrice as much force to give it an equal degree of motion, or to stop it after it has been put into such a motion.—(see *Momentum*)

The language sometimes used to explain the property of inertia is very much calculated to mislead. The terms resistance and stubbornness to move are faulty in this respect. *Inertia* implies absolute passiveness, a perfect indifference to rest or motion. It implies as strongly the absence of all resistance to the reception of motion, as it does the absence of all power to move itself. The term *vis inertia* or *force of inactivity*, so frequently used, is still more reprehensible. It is a contradiction in terms; the term *inactivity* implying the absence of all force.

MAXIMUM AND MINIMUM.— If any quantity first increases to a certain limit, and afterwards decreases when it arrives at that limit, at the end of its increase it is said to be a *maximum*. If it

first decreases to a certain limit, and afterwards increases, when it arrives at that limit it is said to be a *minimum*.

The characteristic property of a maximum consists in its being greater than the values which immediately precede, and also greater than the values which immediately follow it; and that of a minimum consists in its being less than the values immediately preceding, and also less than the values immediately following it.

The best charge for a rifle is that quantity of powder and size of grain, which will generate a power, expanding from breach to muzzle, increasing the velocity of the bullet on a graduated scale by the accumulation of the elastic fluid, until it obtains its highest, or *maximum*, velocity, just before it leaves the muzzle of the rifle.

MOMENTUM, is the quantity of motion which a body, in moving, has acquired, considered both in regard to its velocity and quantity of matter. *Momentum* is very different from velocity. A light bullet and a heavy bullet may leave the muzzle of a rifle with the same *velocity*, but the *momentum* of the light bullet will be small in comparison with that of the heavy one. The light one, on coming to a state of rest, will perhaps fall harmlessly on the ground, while the other, by its momentum, will strike forcibly whatever is opposed to it. A light bullet will require greater elevation of the muzzle of the rifle, than a heavy one, to hit the same mark, in consequence of the greater mo-

mentum which the heavy bullet acquires; for it is a law in mechanics, that, in bodies of equal densities, small ones lose their momentum sooner than large ones.

The comparative *momenta* of bodies are in a compound ratio of their quantity of matter and their velocity: that is, they are in proportion to the products of the matter and velocity, *when expressed in numbers.* Thus a ball of 4lbs. weight, moving at the rate of 18 feet in a second, would have double the momentum,—that is, it would strike against an object with twice the force that a ball of 3 lbs. weight, moving at the rate of 12 feet per second, would do; because the first product (4 multiplied by 18) is double that of 3 multiplied by 12.

In the direct impact of two bodies the momentum gained by one is equal to the momentum lost by the other. Momentum gained and lost are sometimes called *action and re-action;* and in this sense *action and re-action are equal and opposite.*

Motion, is the passage of a body from place to place. The degree of speed in the motion of a bullet is called its velocity, and is *measured* by the space *uniformly described* in a unit of time, as, for instance, in one second.

Rest, is the state of a body abandoned to itself, and not subjected to the action of any force. The *resistance* of the air, the *force* of gravity, and the *friction* of the ground, cause bullets, once in motion, to cease moving; or to come to a state of rest.

VACUUM.—If we suppose that, by any method, we have been enabled to remove all the air contained in a given space, we say that a *vacuum* has been made in this space. It is literally an empty place, but is generally used to denote a space from which the atmospheric air has been extracted. A bullet moving in vacuo would pass over equal spaces in equal times until it struck the ground, as there would be no resistance from the atmosphere, but only the force of gravity acting on it. It is ascertained that if a bullet were fired through vacuum with different initial velocities, at the same elevation, the ranges would be to one another as the squares of the initial velocities: that is, if the velocity was twice greater, the range would be four times greater; if the velocity was thrice greater, the range would be nine times greater than the first, and so on.

The air rushes into a vacuum with a velocity of 1,350 feet per second—or a little more or less, according to the state of the barometer and thermometer at the time—it follows, therefore, that when a bullet flies at any velocity *higher* than 1,350 feet per second, it must leave a vacuum behind it; and so cause the resistance of the air in front, to be greater *in proportion;* there being no pressure whatever of the air behind.

VELOCITY, is a property of motion, by which it passes over a certain space in a certain time, and is greater or less, according as it passes over a greater or less space in a given time. The *velocity*

of a bullet is the measure of its flight, and is estimated by the rate per second at which it passes through the air. *Velocity* is either uniform or variable. *Uniform* velocity is that with which a body passes over equal spaces in equal times It is *variable* when the spaces passed over in equal times are unequal; in which case it is either *accelerated* or *retarded* velocity. When the successive portions of space described in equal times continually increase, the motion is said to be accelerated (see *Gravity)*, and to be retarded when they continually decrease (see *Atmosphere*, resistance of).

Initial Velocity, is the velocity which a bullet possesses on leaving the muzzle of the barrel; for the resistance of the air causes it to decrease in velocity every instant afterwards. The *initial* velocity can only be practically ascertained when the bullet has arrived at a certain short distance from the muzzle of the piece. There are certain writers on Gunnery who believe in the absurdity that a bullet *gains* in velocity, for a considerable space, *after* leaving the muzzle of the piece!

Remaining Velocity, is the velocity which a bullet possesses when it strikes the object aimed at; and this varies according to distance. For instance, at 100 yards the bullet will strike the object with a greater velocity than at 200 yards, and greater at 200 yards than 300 yards, and so on, in consequence of the *continued* resistance of the air. (See *Atmosphere.)*

CHAPTER II.

ON THE GENERAL PRINCIPLES OF FIRING, AND THE MOTION OF PROJECTILES IN A VACUUM AND THE AIR.

The Line of Fire or Projection.—The Line of Metal or Aim.—Point Blank Range.—The Trajectory, or Line of Flight of the Bullet.—Force of Projection, or Impellant Force.—Force of Gravity, or the Earth's Attraction.—Vacuum.—Parabolic Curve.—The Resistance of the Air.

THE general principles of firing are deduced from the relations of position existing between three imaginary lines, called, *The line of fire, or projection; The line of metal, or aim;* and *The trajectory, or line of flight of the bullet through the air.* These lines are often confounded one with the other, though they differ very considerably, and this difference increases as the range is greater.

By *the line of fire, or projection,* is meant the axis of the barrel indefinitely prolonged. It is the primary direction of the centre of the bullet; a direction which this centre would not cease to follow if the bullet were subject to the propelling force of the powder alone.

The line of metal, or aim, is a straight line passing along the centre of the back sight, and the top of the front one, to the object aimed at. The line thus obtained is called the *artificial* in opposition to the natural line, which passes through the highest points on the breech and muzzle of the barrel; and which is also called the natural point blank aim. In rifles provided with a back sight, having a scale and movable slide, a particular point blank range corresponds to each movement of the slide; the point blank range, therefore, increases when the slide is raised, and decreases when the slide is lowered; for point blank range, both in theory and practice, means nothing more than that the object fired at is at the point of intersection between the line of sights and the line of flight of the bullet. The line of metal forms, with the line of fire, an angle more or less obtuse, which is called the angle of intersection. In order that the *aim* should be good, it is requisite that the two points determining the line of metal, and the object aimed at, should be in the same right line.

The trajectory, or line of flight of the bullet, is the curve described by the bullet in the air, in its course from the barrel to the object aimed at. As long as the bullet is within the barrel, the trajectory is identical with the line of fire, but as soon as it has cleared the muzzle, the trajectory diverges from the line of fire, and this divergence becomes greater the further the bullet is from the rifle. By raising the slide of the back sight, the muzzle of the rifle is

elevated, the trajectory of the bullet is raised, and the range increased. By lowering the slide of the back sight, the muzzle is depressed, the trajectory is lowered, and the range of the bullet is decreased. The line of fire, with a properly fitting bullet, is constantly above the trajectory, and is a tangent to the latter towards the muzzle of the piece.

The line of fire, or projection, and the *line of metal, or aim*, will be easily understood on reference to the diagrams; but the *trajectory*, or *line of flight* of the bullet, will require further explanation, in order that the *cause* of the bullet being drawn downwards may be clearly understood; and by what *forces* it is urged from its first direction, the *line of fire*, or *projection*.

A body impelled into a state of motion by any given force, with no obstacle to interrupt it, or attractive force to draw it aside, would move forward, as a matter of necessity, from its property of *inertia*, in a straight line for ever. A bullet, therefore, launched into space, in a certain direction, and endowed with a certain velocity by the force of the powder in the barrel, would continue to move on in the same direction, and with the same velocity, if new forces did not change or destroy the effect of the first. During its passage through the air, however, it is subjected to three different actions, all working together at the same time, namely—

1. The Force of Projection first given to it.

2. The Force of Gravity that draws it to the ground; and,
3. The Resistance of the Air through which it passes.

Now, in order to form a clear idea of the subject, let us suppose, for instance, that the path of the bullet through the air is subjected alone to the influences of *The Force of Projection*, and *The Force of Gravity;* or, in other words, that the bullet travelled through a vacuum, or non-resisting medium.

The velocity of the bullet, at the instant it leaves the barrel, is called the *initial* velocity. The impellant force, or force of projection, would, therefore, urge it on in a straight line, at a uniform velocity with that with which it left the rifle; but the instant it leaves the barrel, the force of gravity, or the earth's attraction, commences work, and, during the whole time of its flight, is drawing it down to the ground, and that with an *accelerated* velocity. (See *Gravity*, Chap. I.)

Suppose, then, that a bullet starting from A (Plate, fig. 1) with a velocity of, for instance, seventy-five yards per second, and following the direction A B, the line of fire. The line A B, as far as G, being marked off into four equal distances by D E F and G, representing seventy-five yards each, through which points the bullet would pass in one, two, three, and four seconds, if subjected alone to the force of projection. It must be evident, however, from what has been said on the

subject of *gravity*, in the previous Chapter, that, by the time the bullet has reached the point D, it will have been attracted downwards a distance of one part; at E it will have been drawn down four parts; at F, nine parts; and so on until it has reached G, when it will have been drawn down to the horizontal line C, or point blank range, a distance of sixteen parts from the line of fire. This being at the end of each second according to the square of the number of seconds, that is, the number multiplied by itself, as has been already explained.

By this we find that the bullet traces, while under the action of gravity and the projectile force, a peculiar curve, called a parabola. We also find that this curve changes its form in proportion to the extent of the initial velocity; for if the velocity be greater, the curve will be less bent, that is, it will approach nearer to a straight line: but if the velocity be less, the curve, or path of the bullet through the air, will be more bent, that is, it will rise higher towards the centre. Thus it is that an alteration in the elevation of the rifle, or original direction of the bullet, modifies the form of the curve; for, with a low velocity, the muzzle of the rifle requires to be elevated, and, with a high velocity, it requires to be depressed, in order to hit the same mark. All the different curves, however, that are traced by a bullet moving through space, are called parabolas, or parabolic curves.

By tracing a diagram similar to Fig. 1, but with a higher elevation, or line of fire, A B, and another with a lower elevation, it will be found that,—though the curve in the one will be more bent, and in the other nearer a straight line,—by drawing a perpendicular line from E down to the 150 yards, it will divide each curve into two symmetrical parts; that is, if the plane containing the curve be bent back, taking the perpendicular line as the hinge, that portion of the curve lying on the right of E will exactly coincide with the portion of the curve situated on the left, and this will be found to be the case whatever the elevation may be.

What has heen said, however, is to be understood of projectiles moving in a non-resisting medium; for when the *resistance of the air*, which is enormously great, is also considered, the path of the bullet deviates greatly from the parabola, and the determination of all the circumstances of its motion becomes one of the most complex and difficult problems in nature.

The *resistance of the air*, being the *third* influence to which the bullet is subjected, will now be taken into account.

When a moveable body is launched into space, it meets particles of air at every instant of its movement, to which it yields part of its velocity, and, as the resistance of the atmosphere is a constant force, the velocity of the bullet decreases every instant from the commencement of the

motion to the end. The speed of projection, or initial velocity, therefore, cannot be maintained the same in the atmosphere as in a non-resisting medium, for the resistance of the air unceasingly diminishes the velocity, and the curve represented by the bullet can no longer retain the true parabolic form, since the distances A D, D E, E F, and F G, through which the bullet passes in a second of time each, instead of remaining equal, must be progressively shortened, and the trajectory raised in proportion to the range of the bullet; see Fig. 2.

Thus at leaving the muzzle of the barrel A, the bullet, endowed with its greatest velocity, will yield but little to the resistance of the atmosphere, and, apparently, but slightly to the action of gravity; for at D, the end of the first second of time, the curvation of the trajectory will be very trifling. After another equal interval of time at E, the bullet having lost a portion of its first velocity, in consequence of the atmospheric resistance, gravity will have drawn it down four times as far as it had done during the first second of time before it has passed a space in length equal to the first, having only arrived in this interval at the point marked 120 yards; and the curve, which the bullet will describe in this second interval of its motion, will generally possess a more marked curvation. After a third equal interval of time, F, the bullet having lost a still greater portion of its first velocity, in consequence of the continued

resistance of the atmosphere, gravity will have drawn it down nine times as far as it had done during the first second of time, A D, before it has passed a space equal to the second, D E, as it will only have reached the point marked 159 yards, and in this third interval the curve will possess a still greater curvation; and the greater will this curve be the nearer it is to the target or surface of the earth; as may be seen on reference to the diagram, Fig. 2, which I have carefully drawn from actual measurement made on the field.

This was accomplished by placing screens, made of tissue paper, of from two to three feet square each, at every twenty-five yards, just above the line of aim; firing from a rest direct at the bull's eye. From the rest to the spot where the bullet struck, a horizontal line was formed by marking it off under each screen; and from this line the distance was measured to the spot where the bullet passed through each screen; on its flight to the target. The length of the paper will not admit of the extent of the range, and height of the flight of the bullet, being drawn in correct proportions to one another; but, in the trajectory, the relative height of the bullet is given, at every twenty-five yards; the highest point of flight being twenty inches above the line of aim, and that a little in advance of the 125 yards. As rifles, from a combination of circumstances alluded to elsewhere, do not all shoot alike strong, the height of their trajectories will not always be the same.

For the space of 200 yards it is comparatively easy to make a diagram of the flight of a bullet through the air; but the determination of the flight of a bullet through a non-resisting medium becomes a more difficult matter; the diagram, Fig. 1, must, therefore, be taken as an approximation only, sufficiently close, however, to give a general idea, comparing it with Fig. 2, of how much a bullet is retarded by the resistance of the atmosphere.

Dr. Hutton, the celebrated mathematician, found, by experiments, that the resistance of the air amounts to near 100 times the weight of the bullet, viz.: when it moved with a velocity of 2000 feet per second; and as bullets sometimes move with a velocity of from 2000 to 3000 feet per second, on leaving the muzzle, the resistance of the air may be easily conceived to be much greater; as the *resistance* of the air increases according as the initial velocity of the bullet is greater. Daniel Bernoulli, another eminent mathematician, proved that a ball that ascends only 7,819 feet in the air, would have ascended 58,750 feet in vacuo, being nearly eight times as high. With such facts as these before us, there need be no difficulty in understanding why the trajectory in Fig. 1, is so much lower and longer than in Fig. 2, although both are but approximations, the length of the paper not allowing the real proportions to be given.

In fact, all experiments agree in proving that the air offers very great resistance to the swift motions of military projectiles, and that the track

described in the atmosphere, by the flight of even the heaviest shot, is not a true parabola, nor anything near it, except when they are projected with very small velocities. This cannot, for a moment, be doubted by any one who, in a proper situation, views the flight of stones, arrows, or even shells, thrown to any considerable distance; for they are seen to descend through a curve manifestly shorter and more inclined to the horizon than that in which they ascended, and the highest point of their flight, or vertex of the curve, is much nearer to the place where they fall on the ground, than to that from which they were at first discharged.

CHAPTER III.

ON GUNPOWDER.

Its Theory and Properties—Force or Pressure—Velocity of the Flame—A Gradually Increased Impulse Necessary—Proper Quality and Quantity for a Charge.

IT is a very common, though erroneous opinion, that fine-grain gunpowder is necessarily the strongest, and, as a matter of course, the best adapted for rifle shooting. Nothing, however, can be further from the truth, and the reason I shall endeavour to explain.

It is well known that gunpowder is composed of charcoal, sulphur, and saltpetre. From experiments which have been made, with great care, the following properties may be deduced :—1. A certain degree of heat is requisite to set fire to the combustible bodies, and decompose the saltpetre. 2. The degree of heat must be increased in proportion to the rarefaction of the surrounding air. 3. The decomposition of the saltpetre being always progressive, the more intimate the mixture, and the juster the proportion of the combustible ingredients, the sooner will it be effected. 4. In the decomposition of saltpetre, a permanent elastic fluid is generated.

There seems to be nothing in the fabric of gunpowder that can alter any of the properties of the constituent parts, taken either individually or collectively. The necessity of having a combustible body capable of producing the total and almost instantaneous decomposition of the saltpetre, makes sulphur and charcoal requisite ingredients: sulphur, because it easily takes fire, and propagates the inflammation, though the heat it produces is not sufficient to decompose the saltpetre: charcoal, because its inflammation, as well as the propagation of fire into all its parts, being slower, it acquires, when it becomes red-hot, a stronger degree of heat than the sulphur, and is therefore more capable of producing the entire decomposition of the saltpetre.

Fired gunpowder preserves constantly the properties remarked in the combination of its ingredients; modified, nevertheless, by the exactness of the mixture, the size of the grains, and other circumstances that will be pointed out.

All degrees of heat are not sufficient to fire powder, as may be proved by throwing several grains near hot coals. The burning of the grains contiguous to the coals will be so instantaneous, as not to be distinguishable from the inflammation of the sulphur; but the grains at a little distance from the coals will emit, after some time, a small, blue, lambent flame, which at length becomes brighter; the intenseness of the fire increases, and the gradual destruction of the saltpetre is clearly

discernible; some of the grains are consumed, while in others the blue flame disappears without producing their destruction: at length the more distant grains become warm, without emitting any flame, or being consumed. This may be exemplified by putting some large grains on an iron plate, which may be put near to, or drawn back from the fire, in order to give it different degrees of heat; or by directing upon them the solar rays, united by means of a convex glass, as different degrees of heat may be produced by augmenting or diminishing the circle formed by the re-union of the rays.

These experiments prove that gunpowder, like other combustible bodies, may become hot or inflamed, without being in the same instant consumed. It is necessary, therefore, to distinguish between the inflammation and the final destruction of each grain; for fire, when applied to two grains of different sizes, does not always cause any *sensible* difference in their destruction; yet there is a great difference in the *force* of two equal quantities of powder, made with the same proportion of ingredients, of the same quality, but differently granulated.

The following experiment will prove that the degree of heat to fire powder should be greater in proportion to the rarefaction of the surrounding air:—

To the plate of a pneumatic machine, let a thin thimble of beaten brass be joined with the convexity upwards, and an opening made below leading into

the cavity of the thimble. Fit a moveable ring, about a quarter of an inch broad, round the thimble, so that on covering the convex end of the thimble with powder, part may fall on the ring. Then if a rod of iron, with a head to fit the thimble, made red-hot, be introduced into the cavity of the thimble, when covered with powder, in the open air, the powder will instantly explode; but if a glass receiver be placed upon the plate, and the *air in part exhausted,* and the hot iron be applied, the explosion of the powder will not be so sudden as before, and part of that on the ring will remain unaffected by the heat, in proportion to the quantity of air left in the receiver. When the air is quite exhausted, the powder upon the thimble will liquefy before it takes fire, after having emitted several ebullitions, then explode at once, and cover with its flame the powder upon the ring: this will, nevertheless, not liquefy, and a part of it will remain on the ring and plate, where it will be pushed by the blast.

This proves that the powder upon the ring, being in a very rarefied medium, does not burn though surrounded by the flame of the fired powder. In this case, the fired powder spreading itself on all sides in the receiver, which is much larger than the space occupied by the powder, the grains that remain unfired are only surrounded by a part of the flame. If the receiver were filled with powder, the fire, enclosed in a smaller space, would be more intense, but the quantity of fired powder would be

proportioned to the rarefaction of the atmospheric air contained between the grains.

Having ascertained the first two properties, it remains to demonstrate, that when fire is applied to grains of powder, the inflammation of the contiguous grains, and the destruction of each individual grain, takes place progressively; and that the velocity with which fire spreads itself on all sides to inflame the contiguous grains, is greater than that with which it penetrates into the substance of each grain. It is too obvious to need insisting on, that all motion, however rapid or short it may be, takes up a certain time; though to us, from the shortness of its duration, it appears instantaneous; consequently, the inflammation and entire destruction of powder produced by the action of fire, communicating itself to everything around, like rays from a centre, must necessarily take place in a determined space of time; which varies according to the strength of the fire, the proportion of the ingredients, the nicety of the mixture, and the size of the grains.

When a sufficient degree of fire is applied to one grain of powder, it first acts upon the surface, and then penetrates towards the centre. As the surface burns, a flame is excited which catches the nearest grains, if the degree of heat be sufficient, and the surrounding air not too much rarefied. In the meantime, the fire which attacked the first grain, continues its action towards the centre till it be totally consumed. There are then two distinct

actions in the inflammation and the total consumption of powder: the first is the expansion of the inflamed fluid, which, spreading itself from the surface of the burning grains, surrounds the contiguous ones: the second is the penetration of the fire from the surface of each grain towards its centre. But the flame always spreads with more rapidity between the intervals of the other grains, than it penetrates towards the centre of each grain.

The following observation will prove that a *determined time* is requisite for the consumption of each grain. Make, of the common mixture, to be had at the powder mills, some *large* grains of powder, or balls, varying from one inch to a quarter of an inch in diameter; dry, and set fire to them: it will then be seen that the fire penetrates from the surface to the centre, in a longer or shorter space of time according to the size of the grains; so that, if there be no difference between these large grains and common ones than in size, it may fairly be inferred, from analogy, that the smallest grains that are made must require a certain space of time, to consume, however short it may be. It is likewise clear, that the flame, in spreading itself from the burning grains to the contiguous ones, takes up a certain space of time; as may be exemplified by setting fire to a *train* of powder.

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But it is not sufficient to have proved that the burning of each grain, and the inflammation of the contiguous ones, are progressive; it is necessary further to show, that the activity with which fire spreads itself between the interstices of the grains, is greater than that with which it penetrates from the surface toward the centre of each grain. If we consider that the inflamed fluid, in passing between the grains, meets no other resistance than the common air, which is easily penetrated, by reason of its rarefaction; and that the fire, in insinuating itself from the surface toward the centre of the grain, must pass through a substance much more dense; it is evident, that the resistance in the second case being greater than in the first, the fire must consequently be slower in its progress.

The following experiment will serve in proof of this assertion. Let a short piece of barrel, say eight or ten inches, with one end plugged up, be filled with powder to the muzzle: on applying fire to it, the barrel will instantly empty itself, with an explosion. Let it be again filled with the *same quantity* of powder well compressed, so that the interstices between the grains may be as small as possible, and form, as it were, a solid body; the *time* that the barrel will now take to empty itself will be *sensibly* longer than before.

The great velocity with which the inflamed fluid passes from the muzzle to the breech of the piece of barrel, between the interstices of the grains, is observable in the first experiment; and, in the second,

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From the three preceding paragraphs, the following principles are deducible :—1. That in burning two equal quantities of powder, made of the same composition, but differently granulated, the smaller will be consumed in less time than the larger; because the grains being smaller, present to the fire a greater surface in the aggregate, and produce, at the first instant, the inflammation of a greater quantity of matter; which is consumed so much sooner, as the fire has less space to pass through from the surface to the centre of each grain. 2. That this depends not only upon the size of the grains, but also upon the facility with which the fire passes between them. On the other hand, the grains should not be *too* small, or rammed down tightly; for then the interstices will be so diminished, as to admit the flame to pass with difficulty; and they will be so compact, as to form, as it were, a solid body.

Experiments, of a character too complex to be introduced here, prove, that from fired gunpowder a *permanent* elastic fluid is produced in great quantity, upon which depends its principle force. The quantity of this fluid is always in proportion to the quantity of saltpetre which is contained in the powder, since it alone produces the fluid; as sulphur and charcoal, when burned, produce none. By burning different quantities of powder, of the same or different qualities, under the receiver of

the pneumatic machine; exhausting the air to the same degree in each experiment, and observing the apparent fixed point of a mercurial gage, it would be seen that it sensibly falls or rises in proportion to the saltpetre contained in the different quantities of powder.

According to Mr. Robins, the force of fired gunpowder is about 1000 times the strength or elasticity of common air, or a thousand times stronger than the pressure of the atmosphere. The pressure of the atmosphere is about 15 lbs. on every square inch, and, therefore, 1000 times this, or 15,000 lbs., is the force or pressure of the flame at the moment of explosion, upon a square inch, which is equivalent to six tons and a half. But Dr. Hutton afterwards found, by his experiments, that Mr. Robins was in error with regard to the *heat* of the flame: that it is in fact *double* what he supposed it to be; and, therefore, that the strength of inflamed gunpowder, when fired, *or while the flame occupies only the same space as the powder did before it was fired*, is, on a medium, about 2,000 times stronger than the elasticity of common air, or 2000 times the pressure of the atmosphere; being equivalent to 13 tons on the square inch. From experiments which were made in 1815 and 1816, and also at a subsequent period, it appears that the pressure is somewhat higher than 2000 atmospheres, though not a great deal. It will be found, however, that very erroneous notions, on this subject, have been promulgated by various

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From the three preceding paragraphs, the following principles are deducible:—1. That in burning two equal quantities of powder, made of the same composition, but differently granulated, the smaller will be consumed in less time than the larger; because the grains being smaller, present to the fire a greater surface in the aggregate, and produce, at the first instant, the inflammation of a greater quantity of matter; which is consumed so much sooner, as the fire has less space to pass through from the surface to the centre of each grain. 2. That this depends not only upon the size of the grains, but also upon the facility with which the fire passes between them. On the other hand, the grains should not be *too* small, or rammed down tightly; for then the interstices will be so diminished, as to admit the flame to pass with difficulty; and they will be so compact, as to form, as it were, a solid body.

Experiments, of a character too complex to be introduced here, prove, that from fired gunpowder a *permanent* elastic fluid is produced in great quantity, upon which depends its principle force. The quantity of this fluid is always in proportion to the quantity of saltpetre which is contained in the powder, since it alone produces the fluid; as sulphur and charcoal, when burned, produce none. By burning different quantities of powder, of the same or different qualities, under the receiver of

the pneumatic machine; exhausting the air to the same degree in each experiment, and observing the apparent fixed point of a mercurial gage, it would be seen that it sensibly falls or rises in proportion to the saltpetre contained in the different quantities of powder.

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writers, even so late as 1858. One says that the force is equal to 2000 *pounds;* a second states that it is as much as 75,000 lbs., or 33 tons; and a third, writing on Gunnery, has the hardihood to assert, that it is *seven* times greater than Hutton found it to be!

The *common* air that is within and between the grains of gunpowder, in a charge, contributes likewise, by its heated expansion, to the *force* of the powder when fired. Its absolute force might be easily determined, though it is small compared with the elasticity of the permanent fluid generated from the powder. It is quite enough, however, to show the rifleman the folly of ramming the charge down *tightly*, by which means all the air is forced out. The diminution of the range of fire arms, when heated by frequent discharges, or when the air of the atmosphere is more rarefied, ought not to be attributed to less elasticity in the air, as some do, but rather to the second property of powder, where, being fired in a rarer medium, less takes fire, though the same quantity be used, and hence the range is shortened, as is clearly proved elsewhere.

Powder, however well dried and fabricated it may have been, loses its strength when allowed to become damp. If daily observations on powder, put into damp magazines, and carefully preserved in barrels, are not sufficient to establish this fact, the following experiment will render it incontestable. Let a quantity of well dried powder be nicely

weighed, and put into a close room, where the air is temperate, and seemingly dry, and be left for six or eight hours; on carefully weighing it again, its weight will be found to be sensibly increased. This same powder, exposed to an air loaded with vapour, acquires much additional weight in a short time. Now, the increase of the weight being proportional to the quantity of vapour contained in the atmosphere, and to the length of time that the powder is exposed to it, it follows, that powder easily attracts moisture. Wherefore, if a degree of heat, sufficient only to fire dry powder be applied to powder that is damp, the moisture will oppose the action of the fire, and the grains either will not take fire at all, or their inflammation will be slower. Thus, as the fire will spread more slowly, fewer grains will burn, and the penetration of the fire from the surface to the centre of each grain, and consequently their consumption, will require more time. Whence it may be concluded, that all degrees of moisture diminish the *force* of powder, and that the common saying, "*Keep your powder dry*," has more scientific meaning in it than many, who perhaps unthinkingly use it, even dream of.

The explosive *sound* of fired gunpowder is caused by the rapid derangement of air in the combustibles and the shock of striking upon the volume of the external atmosphere. The explosion is, indeed, a chymical process, in which a tangible material suddenly vanishes into air, and is no more seen. The *velocity* of movement in the flame, as it rushes

through the barrel, is an immediate consequence of the sudden disengagement of the confined air, and, when no bullet or other body is placed before it, is calculated to be at the rate of 7000 feet in a second, or little less than 79 miles per minute.

From what has been said it will be seen, that, when fire has been communicated to the charge by the nippled vent, all the parts of the charge are not ignited *simultaneously*, as many believe, but successively, for only a portion of the powder is at first inflamed. As the combustion proceeds, however, the powder is decomposed, and produces both gaseous and solid bodies; and as the gaseous parts have a tendency to fill a much larger space than that occupied by the powder before inflammation, they seek an outlet where there is least opposition. This outlet, unless the barrel be faulty, is the place occupied by the bullet; the gases, therefore, act forcibly on it, and compel it to exchange its state of rest for one of a very rapidly increasing motion, as it is not until the bullet has traversed a considerable portion of the bore of the barrel, that it is subjected to the greatest action of the powder, by the accumulation of the gases. This propelling force, increased by the successive inflammation of the other parts of the charge, thus acts upon the bullet with a continually increasing urging force, and continues to do so (*if the quality and quantity of the powder, and the barrel, have a right proportion to each other)*, until just before it leaves the muzzle, when it is at its greatest velocity.

The explosion of fine-grain gunpowder being so rapid, the expansion of the gases is so quick, that the whole power is generated and has reached its highest point before the bullet can be much more than half way out of the barrel, leaving it without any increasing propellant power, than that which has been already generated, to contend with the column of air in the remaining part of the barrel, which must be condensed before the bullet can leave the muzzle, and which also causes a very dangerous recoil. The consequence of this is, that a high speed is quickly generated, to be again quickly reduced to a lower velocity by the opposition of the air in the other part of the barrel, as well as by the friction of the bullet. It is in fact too quick to be beneficial; it kicks the bullet, as it were, out of the barrel, and does not communicate to it the momentum which the bullet would otherwise receive, if the impulse were graduated.

This graduated impulse may, however, be obtained by using a powder of a larger grain, for, as it does not explode so rapidly, it would generate a power, expanding from breech to muzzle, increasing the velocity of the bullet on a graduated scale by the accumulation of the powder gases, until it obtained the highest, or maximum, velocity as it left the muzzle; for, as we have seen, the duration of the explosion, or the period during which a continuous generating of force is obtained, is dependent upon the size or *quantity of matter* in

each individual grain, and, therefore the combustion of the whole quantity will be lengthened or shortened, as the grains are larger or smaller.

As very fine gunpowder is too quick to be beneficial, *unless in very short barrels,* a mistake may be made, on the other hand, by selecting a powder *too* coarse in grain for the length and calibre of the barrel to be used, as all the force which such a powder is capable of generating would not have reached its highest point before the bullet had left the muzzle of the piece, and, consequently, a part of the powder would be expelled without being consumed. The grand secret, therefore, in projectile force, consists in a modification of the granulation between the two extremes, in order to suit the capacity of the barrel; and this can only be accomplished by selecting a powder that, as I shall presently show, will have generated all its explosive force, and created its greatest power, just as the bullet is leaving the muzzle. The first and greatest principle is, to arrange so as not to obtain too great a velocity at the *first move* of the bullet, for, as experience as well as philosophy teaches us, a body cannot be forced from a state of rest into a high state of motion in an instant, as it were, but a portion of time must elapse, however short it may be.

The manufacturers of gunpowder have, for a considerable time, been in the habit of preparing a powder specifically for rifle practice, which is known in the shops as rifle powder; and as all

barrels have a size of grain, and quality, that will suit them best, one of these may be better suited for a certain barrel than the others. In order to prove this, procure a small quantity of each, and give them a fair trial by firing, from a rest, a dozen rounds, or more, out of each parcel, on the same day, so that the firing may be made, as nearly as possible, under the same circumstances, with regard to atmosphere, &c.; the rifle being thoroughly cleaned after firing with each sort of powder. In firing, the rifleman should take his stand, say at 300 or 400 yards from the mound or butt against which he fires; and, with the 200 yards sight up, he should aim at the bull's eye, so that the bullets may strike the ground before they reach the target. The marker, who may be standing on one side sufficiently out of danger, can then run across and place marks where the bullets strike. When the firing with each sort of powder is over, measure the ranges, and enter them in a memorandum book, for the purpose of comparison, and whatever powder causes the bullets to range farthest, and closest together, may be considered the best for that particular barrel and bullet.

These experiments, should, of course, be made where there can be no danger—on the sea shore, against a high mound, rocks, &c. Those riflemen however, who may have the benefit of a very large target, say from 12 to 18 feet square, may fire direct at it, and the powder that causes the bullets to range *highest* and *closest* on the target may be fixed on as the best and fittest for that barrel.

With regard to the *quantity* of powder for each charge, that can only be regulated by experience. It must be sufficient, but not superabundant, for it is easily proved that beyond a certain limit, different in rifles of different proportions, the increase of the charge has a bad effect on the precision of the fire, and range of the bullet. It is, therefore, of importance to determine for each rifle, a charge in proportion to its length and calibre; and this proportion will be governed by the size of the grain and quality, and the resistance offered to its expansion by the *inertia* of the bullet; as no more than a certain quantity can be *effectively* consumed in any rifle. In fact, the best amount for the charge will be found to be the *least* quantity that sends all the bullets *farthest* and *nearest* to one point; or, in other words, that keeps them *closest* together; the principal object being to obtain the greatest result with the least means. When, by repeated experiments, it has been ascertained what sort of powder, and what amount of charge, is the best calculated to effect this, adhere to the same on all occasions, *and at all ranges*, especially when competing for prizes, as the rifleman will then know what he has to depend upon, when a trial of skill takes place.

CHAPTER IV.

ON THE SELECTION OF A RIFLE, OR GIVING AN ORDER FOR ONE TO BE MADE.

Calibre, or Size of the Bore—Length of the Barrel—Nipple—Grooves—Number—Degree of Spiral—Lock—Trigger—Stock—Ramrod—Sights—Breech-loaders—Double-barrels—Bullet—Lubricator.

A GREAT deal has been said about the *Minie* rifle. We have had no such weapon; it is quite a misnomer; and, what is more surprising, the name is often made use of by those who ought to know better. There is what is called the *Minie* bullet, it is true, and a great deal of good shooting has been made with it (compared with the old spherical ball), but its success has been entirely owing to its *practice* being in direct opposition to the *theory* of its inventor! He tells us that the cup or plug is *driven* in. *Practice* replies that it is no such thing; and practice is, in this case, the soldier's friend. If the plugs and cavities were so constructed—that is, if they were made a little more cylindrical in form, so as to permit of the plugs being actually driven in by the force of the explosion, the most frightful consequences would be the result; for the cup or plug would not stop at the bottom of the cavity, and *there* resist the powerful agent that

drove it thither, but the fore part of the bullet—plug and all—would often give way, and be carried off by the tremendous force of the gases, leaving the cylindrical portion of the bullet sticking fast in the barrel, and the soldier helplessly exposed to the enemy's fire, without his being able to load and fire another shot. It is, indeed, fortunate for him, that the "Minie" system *is* a fallacy; for were it otherwise, nothing but disaster would attend our arms. This is no mere theory, but a fact, which is supported by the strongest experimental evidence, and which the want of space alone prevents my now placing fully before the reader; for it is melancholy, to think, that this most absurd theory, still finds believers, even among the Instructors of the British Army!

In the selection of a rifle, or in giving an order for one to be made, there are two important points to be attended to; namely, the *bore* of the barrel, and the *nipple*.

To be suitable for government ammunition, the barrel should be exactly 577-thousandth parts of an inch in the diameter of the bore. And I would recommend that the bore be made the same diameter from end to end, or, as some call it, a *true* cylinder. Its exact size, measured in this manner, should be insisted on; taking the government standard as a proof; for though it is what is technically called a 24-bore (that is, the diameter of a spherical ball weighing 24 to the pound) gunmakers' gauges do not always agree in their size,

as may be easily proved The cause of this discrepancy arises from the fact that many of the gunmakers' gauges are not made according to any recognized authority; but are simply what they have been in the habit of using in their various establishments for a length of time.

The length of the barrel of the military rifle for Rifle regiments, is two feet nine inches; but even two feet six will be found to be quite sufficient, if the charge, in quantity, and quality, is carefully attended to; for, as I have shown in Chapter III., it matters not what the length of the barrel may be, if the *size* of the grain, and the *qnantity* of powder, is not suited to its capacity.

The length of the barrel of the Enfield Rifle Musket is three feet three inches, but that musket is intended, with its bayonet, to be used as a pike, in charging; the extra length of the barrel adding nothing to its shooting qualities.

The *nipple* ought to be the same size as the military one, in order that the Government percussion caps may fit properly.

I am an advocate for a somewhat heavy rifle, as the shooting with such a weapon is always more steady, with less recoil; particularly if the weight of the metal is judiciously accumulated behind and immediately surrounding the breech. At the same time it should not be too heavy. If too light, the rifleman would experience an insurmountable recoil; if too heavy, it would be difficult to manage, and, besides its weight, which would no longer be

in a ratio with the average strength of riflemen, would render its carriage impossible during a long march, or a campaign. The barrel of one I am now about to describe is 2 ft. 6 in. in length; weight $5\frac{1}{2}$ lbs. The bore is exactly half an inch in diameter; a size which the great majority of our practical marksmen agree now in recommending. I am not favourable to four grooves, for this reason: when the bullet leaves the muzzle of the piece, it is made by the force of the explosion nearly *square*, or four-sided, especially if the grooves are deep, causing a considerable amount of extra friction, and, consequently, retardation, by its grinding motion, while passing through the air. I have therefore fixed on five, though, from my style of grooving, many have supposed the barrel to be a smooth-bore.

In order to understand the mode of grooving thoroughly, I must ask the reader to draw for himself, on as large a scale as he pleases for the sake of distinctness, the geometrical figure called a *pentagon*. Then, in the centre, let him draw a circle, so that its edges may just *touch* the side of the figure. This circle is to represent the end of the bullet. The next process is to round off the angles of the figure to rather less than a *third* of their original depth, when they will appear to be *broad, shallow grooves*, somewhat like the second diagram above; the first

Fig. 1.

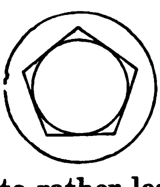

Fig. 2.

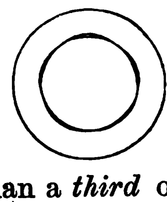

diagram representing the figure before the angles were rounded off.

The twist of the spiral is at the rate of one turn in five feet, which generates a rotatory motion quite sufficient for a range of one mile, for, as there is little friction, comparatively speaking, to retard the progress of the bullet *in* the barrel, it proceeds with greater velocity after leaving the muzzle, thus rendering a less amount of twist necessary than in a barrel having more friction.

Taking into consideration all the experiments I have made myself, all I have witnessed in other quarters, and all the experimental reports I have read on the subject, this is the mode of grooving which I still prefer, and which I recommended to our authorities in the autumn of 1853, and again in1855. I have loaded and fired hundreds of rounds from such a barrel without the slightest trouble, the last bullet going down as easily as the first; in fact, a glance at the diagram will show any man conversant with the subject that there can be no friction that cannot be overcome by merely *pressing* the ramrod gently and steadily down, so that the shape of the bullet cannot be destroyed, nor the powder caked, by the bullet being jammed down upon it.

This mode of grooving requires only *attention* on the part of the workman, without which any sort of grooving becomes worse than useless, disappointing and deceiving the man who pays a high price for a showy and, *said to be*, superior weapon.

The cutter should be just a fifth of the circumference of the bore, and very shallow, and care taken not to go so deep as to affect the five points of the original surface where the bullet is seen to touch the sides, leaving the bore without any sharp edges.

The above is the description of a favourite rifle barrel which I keep for private use; those, however, who propose joining Volunteer Rifle Corps must be provided, as I have already stated, with one having a *bore* ·577 inch in diameter, in order to admit of the Government ammunition being used, in case of actual invasion. That every individual of a Rifle Corps should be tied down to the present system of grooving, if a better can be had, so as to allow of easier loading, and to prevent fouling, seems to be inconsistent with the spirit of improvement which has lately been so publicly recognised and rewarded; and, therefore, the mode of grooving which I here recommend (or a better, if it can be found), will, no doubt, be allowed, *provided* the bore is made ·577. Four hundred of these rifles have already been made, and the shooting with them has been pronounced, by competent judges, to be everything that can be desired.

The apparatus for testing the military gauge consists of two plugs, one of ·577 inch, and another ·580 inch. The rifle, to be serviceable, must admit the former, and exclude the latter. All the barrel makers in Birmingham, and the "setters up," in that town, as well as in London, are provided with similar plugs to those which are used in the "view

rooms" at those places; and as the arms of each corps will be subject to an examination by competent viewers from the Government Small Arms Department, commanding officers of corps, and all who purchase arms, should hold the manufacturers responsible for the correctness of the gauge of the barrels and the nipples.

The mechanism and form of the interior of the *lock* is best left to the gunmaker, who, for the sake of his own reputation, may be expected to furnish one that will do himself credit. The hammer, when at half-cock, should be at such a height from the nipple as will admit of the cap being placed on it without inconvenience. In many locks this is not the case, as they require to be placed on *full* cock before capping. This should never be allowed, as the danger arising from a worn or faulty sear or tumbler cannot be compensated by any ideal advantage this plan may be supposed to have.

I am no advocate for *hair* triggers, as they are apt to get out of order, and become dangerous even in the hands of the most careful men. If triggers generally were made longer and straighter and fixed into the stock so that the sear would rest on the very end of the upper part of the trigger, it would be a great improvement, as a lighter pressure of the finger would be required in consequence of the increased *leverage* that would be gained. The finger ought lightly to *feel* the trigger; with a hair trigger this is almost impossible, without running the risk of letting the rifle off before the rifle-

man has properly covered the object intended to be hit.

In rifle shooting a *long stock* is invaluable, as it can be held so much more steadily to the shoulder. Some require longer stocks than others, but all should be made as long as the shooter can, without inconvenience, bring to the shoulder. The fore part if not *full* stocked, should be carried at least thirteen or fourteen inches in front of the guard, so that the left-hand may grasp the wood-work instead of the barrel alone, when holding the rifle properly. The stock should not be too much bent, or, in long range firing, the heel of the butt will require to rest on the breast or side, instead of the shoulder.

Ramrods in general are not made thick enough. A wooden one made nearly as thick as the bore of the barrel would be much more effective in ramming down the bullet straight, so as to preserve its axis in a true line with the axis of the barrel. It would also enable the cup at the end to be made larger, and of a better form for pressing down the bullet without injuring its shape. But, for military purposes, wooden ramrods are not strong enough; and iron ones, if made thick enough, for a good grasp, would be too heavy.

The ramrod I use is strong, thick, and showy, and not too heavy; it is simply a common military iron ramrod covered with Buffalo horn; the metal knob at the top, and the cupped metal bottom, being rivetted to the iron rod. The cost of covering with

horn is about five or six shillings. In loading with this rod, it does not require to be turned, as does the military one. Some gunmakers may object to a *thick* ramrod, as interfering with the elegant appearance of a rifle; but apparent solidity in a military rifle cannot be a fault, so long as it does not add any unnecessary weight to it, and the benefit accruing from a thick ramrod would a thousand times counterbalance any drawback it might be supposed to have in appearance. If good shooting is to be sacrificed to lightness and elegance of appearance, there would be an end to all improvement in the rifleman's practice.

Rifles are generally *sighted* for the different distances by the gunmaker; but as all do not take aim alike, some taking the front sight fine, while others take it full, in the line of vision; it would be better for the purchaser to have the back sight marked with a graduated scale of—say twenty parts to the inch, and then mark upon it his own distances according as he progresses in practice. By this plan he would be able to mark the scale to suit his peculiar mode of taking aim, and also in accordance with the quantity of powder he is in the habit of using, otherwise some compensation will most likely be required to be made by elevating or depressing the muzzle of the rifle, which is not always a satisfactory mode of firing at a distant mark.

The best *front* sight is what is called the "false bead;" that is, in looking at it, from the breech,

it appears like the head of a black pin; but looking at it sideways, it stretches rather more than a quarter of an inch along the barrel, in order to add strength to the apparent neck of the pin. It should be made a *dead* black, as silver, or any other bright material, deceives the eye, and is a great drawback to fine shooting.

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The best breech sight I have shot with, is one of my own contrivance. See Plate, Fig. 3. A, is the side view; it is supported in the upright position by the pressure of a spring at the bottom G, but which permits it to be laid flat on the barrel, either backwards or forwards. B is the front view. The peculiarity consists in the slide C being made to move upwards or downwards, by turning the screw pillar E with the finger and thumb, that part of the slide at D forming a nut to the pillar E, a flat threaded screw. By this means the slide may be moved with rapidity and certainty to any part of the scale marked on the pillar F, and (if the parts are made to fit correctly) remains where it is placed, without being moved by the shock of the discharge during firing. Between C and H a fine line of platina is inserted, over the top of which the eye takes aim. The platina line, it will be seen, leads to the centre of a *curve*, which is less apt to deceive the eye, when taking aim, than the common V notch.

The question has been asked, should volunteers be armed with Breech-Loaders? Some have answered this question in the affirmative; the only

reason given being the *rapidity* with which they can be charged. Not a word is said as to their superior *accuracy*, which, with riflemen, is the all important point to be considered, in choosing or giving an order for a rifle. For soldiers of the line, who cannot always aim at a particular object, in consequence of the clouds of smoke which envelope them, breech-loaders, of a superior description, might possibly be recommended; but, for riflemen, who should never *throw away* a single shot, mere *rapidity* of fire ought never to be encouraged.

A high authority says, with reference to the new musket of France, "It is a general supposition, that it would be a great advantage to be able to fire, in the same space of time, a greater number of rounds; and the supposition is true, were the *number* of rounds only concerned, but it is less so of shots fired without aim, and in warfare such is the difficulty of transport that the power of expending ammunition exceeds that of the means of conveyance; therefore, the constant anxiety of persons in command is to check random firing, rather than to increase it. *Improvement, then, is not required as to an increase of the number of shots fired, but that they may be so with more correctness, and to a greater distance.*"

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This [illegible] however, may be [illegible]

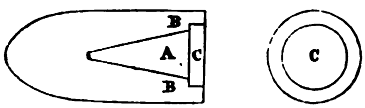
say ten rounds at every 100 yards, from 500 up to 1000 yards. Let him do the same with the *best* muzzle-loader he can procure, and whichever rifle makes the most of the sixty rounds, is the best for him, be it the one or the other. The power of doing the greatest amount of injury, with the *same quantity* of ammunition, at the greatest possible distance, being the *primary* consideration for a rifleman.

The same amount of ammunition should be fired on different days without cleaning the rifles, in order that their state may the more nearly resemble that which they are often in, when employed in actual warfare.

The question has also been asked, should riflemen have double-barrels? I would answer, No. Double-barrelled rifles are much less likely to be correct than single ones, owing to the difficulty of placing the axes of the barrels exactly parallel with each other, so that each barrel would shoot equally well, with the same sighting, at all ranges. Besides, there is the danger of making very serious mistakes in loading, during the heat of an engagement, or even on the ordinary practice ground. Leaving one barrel unloaded, for instance, and loading the other with a double charge; of putting the powder into one barrel and the bullet into the other, the attention having been attracted for an instant from the act of loading; of touching the wrong trigger, &c., all of which

are grave objections to the adoption of *double-barrels* for riflemen.

The Bullet I recommend, is also one of my own contrivance, and is known by the name of the "Disc Bullet." It is what is commonly called *Cylindro-conoidal* in its outward form. That which I generally use is about 1 1·16 inches in length, as represented by the diagram; though it may be made longer, if the rifleman desires a heavier one for particular purposes.



In the end of the bullet, which is a *fair* cylinder for half its length, I have a cavity formed as shown at A, which extends a little more than half the length of the bullet. Upon the edge of the cavity B B, I place the round disc C, which is cut out of thin iron to fit exactly, so that it will not drop out after it has been pressed in by the thumb or gently on a table. When the explosion takes place, the disc becomes so firmly fixed by the contraction of the lead around it that it never falls out, nor is it driven, or intended to be driven, further in than the rest of the lead at the base of the bullet.

Experience shows that the "disc" bullet rifles itself as distinctly as if it had been cast in the grooves of the barrel: a complete answer to the *supposed* effects of all such nonsense as the "expanding" cups and plugs which many, who ought to know better, still believe in. It may also

be called a single bullet, for any number may be fired at a distant object over the heads of bodies of men employed in moving in the intermediate space, without any fear of the discs leaving the bullets, like the cups or wings of the "Minié," and injuring the men. I have fired thousands of these bullets, and, though not a first-rate marksman, I have repeatedly placed 70 per cent. of them in a space 2 feet broad by 4 feet high, at 600 yards distance. This can be corroborated by unquestionable evidence.

Mr. Greenfield, of Broad-street, Golden-square, has been in the habit of making my bullet-moulds, and, as my object is to encourage rifle-shooting, he has full permission from me to make moulds of this pattern for any gentleman applying for the same. In giving the order, however, I would recommend the barrel to be given to him, with instructions to make the bullet large enough just to touch its sides, but to fall to the bottom by its own weight. My reason for advising this is, that I never use paper or patch, but simply dip the bullet half way in a *very hot* mixture of two parts bees' wax, one part soft-soap, and one part tallow or hogs' lard, the refuse being previously carefully skimmed off. I generally mix a few pounds of these ingredients together at once, as it has then only to be made thoroughly hot and liquid for use at any time afterwards. The bullets should be placed on a warm hob, or plate, for a few minutes before

dipping, as the cold lead is apt to chill the mixture too suddenly, and thus take on too thick a coating, which, instead of going into the barrel, will all strip off at the muzzle. The thinest coating possible is quite sufficient.

Some years ago, when carrying on an extensive course of experiments with bullets of various sizes and forms—some with paper wrapped round them like the Service ammunition, some with patches, and others in a *naked* state—I became so satisfied of the superiority of the "naked" bullet, and its simplicity in loading, over other methods, that I have continued ever since to use such for my own private shooting. Our most scientific military authorities have also lately declared themselves in favour of this system. One says: "The employment of a naked bullet, thus doing away with that interfering medium, the paper, will be a matter of great importance if we can succeed." Another says: "I entirely concur in what has been said as to the advantages to be derived from the naked bullet in preference to one with paper; it is evident that the naked bullet properly supplied with grease will fill the grooves of the rifle better than one which has the intervening substance of paper around it." A third adds: "In my opinion, it is to the paper alone the defects in fouling and accuracy are attributable; bullets have lately been constructed and used without paper, and the result has been that these bullets

have not only shown themselves superior to the plug, but barrels which would have been rejected with the latter as bad barrels, have produced greater accuracy than has ever been obtained with the plug ammunition." These are the opinions of officers of high standing, who have devoted much time to the study of rifled arms, and are, therefore, worthy of every consideration.

Chapter V.

ON LOADING, PRESENTING, AND TAKING AIM.

Rules to be attended to on arrival at the ground, and during Ball Practice—"Prepare to Load"—"Load"—Remarks on Loading—"Ready"—Remarks on presenting and taking Aim.

In order to preserve a soldier-like demeanour, when under arms, as well as to prevent accidents, the following rules should be attended to at all meetings for ball practice:—

1. On the order being given, the men will "fall in" in single rank, with arms at the "shoulder," (*see* Manual exercise) about six paces in rear of the firing line.

2. The names of the men will be entered on the target card, in the order in which they stand in the rank, commencing from the right.

3. The command "prepare to load," and "load," will be given; and, after loading the men will "stand easy" with their rifles at the "order." In this position they will be permitted to converse with one another, in an under tone, but on no account to make remarks on any shot.

4. On the first number being called, the rifleman will "shoulder arms" and advance to the firing line, and on the word "ready" being given,

he will "cap," "present," and "fire," without any further order, and then return to his place in the rank and load again.

5. In order to save time, the next in rotation will advance to the firing line, without waiting for his number being called, and there remain, with arms "shouldered," until the word "ready" is given.

6. One or two preliminary shots will be permitted to be taken previous to commencing the regular practice; and any man will be allowed, during practice, to see the state of his score; but he must do so before he re-loads, and then return immediately to his place in the rank.

7. A forfeit, to the marker's and medal fund, shall be incurred for every breach of any rule: and the payment of all forfeits will be rigidly enforced.

8. These rules to be in force on practice days, from the time the words "fall in" are given, until ordered to "shoulder arms," "right face," and "lodge arms," the signal for dismissal.

The men having been formed in single rank, and told off, as directed, the command "prepare to load," should be given. This is performed in three motions, as follows:—1st. Bring up the left hand and grasp the rifle in a line with the shoulder. 2nd. Bring the rifle down with the left hand, at the same time grasp it with the right hand between the sword-bar and the left-hand; turn the barrel outwards, and place the butt so as to rest close inside the heels; the muzzle should be in a line with, and

about six inches from the centre of the body. 3rd. Bring the right hand to the cartridge pouch, or powder flask; at the same time shift the left hand close up to the muzzle of the rifle.

In loading the rifle it is not advisable to do so by certain words of command; such as, "load," "draw ramrods," "home," and "return ramrods;" as the *greatest care* is necessary in loading to render a correct aim of any avail. The word "load" should, therefore, alone be given.

On the word "*load,*" take a cartridge in the right hand, and press the thumb and second joint of the fore-finger firmly on it, just above the powder; then with the fore-finger and thumb of the left hand, close to the right one, wrench the twisted paper at the end carefully off without shaking the cartridge; the muzzle of the rifle resting on the wrist of the left hand, while doing so. In pouring the powder into the barrel, it will run more freely if the opposite sides of the mouth of the cartridge to those which were pressed by the finger and thumb are pressed back again to their original form by the fingers of the left hand. Insert now the mouth of the cartridge into the muzzle of the barrel, and carefully shake the powder into it; then, with a turn of the fore-finger and thumb, reverse the cartridge and place the bullet, conical point upwards, firmly in the barrel, as far as two-thirds of the length of the bullet; twisting off, smartly, the remainder of the paper close to the muzzle. If the last motion is performed *smartly,*

the paper will separate more *evenly* round the edges of the muzzle of the barrel.

In using a *naked* bullet, as recommended in Chapter IV, the operation of loading is very simple, as the powder, whether kept in a flask or in separate paper cartridges, has only to be carefully poured into the barrel, and the bullet pressed down into the muzzle, by the thumb.

Patches are unfit for bullets having fair cylindrical sides, as they require room to double up at the edges, and this space can only be afforded, properly, by the sugar-loaf form, which is very inferior to the cylindrical.

After having seated the bullet in the muzzle of the barrel, draw the ramrod half out with the second joint of the fore-finger and the thumb; then grasp it near the muzzle and draw it quite out, turn it, head to the front, and place the cup-formed end on the bullet, guiding that end of the ramrod with the fore-finger and thumb of the left hand: bend the legs so as to catch and support the rifle between the knees, and, with *both* hands, *press* the bullet gradually and steadily down until it reaches the powder. This may be done with one hand, supporting the rifle with the other, the knees straight, if the bullet is made to fit properly; but it cannot be done so steadily, or with so little harm to the bullet. In loading with the ramrod I have recommended in Chapter IV, it will not require to be *turned*, after drawing it, as the cupped end will be below.

Having pressed the bullet down until it has reached the powder, again grasp the muzzle of the barrel with the left hand, stand upright, draw out and return the ramrod to its place, and then seize the rifle with the right hand below the left; turn the rifle, guard to the front, and, with the right hand, move it to the right side, placing the butt on the ground, close to and in a line with the toes, in the position of "order arms."

Being loaded, the men may now "stand easy," and converse with their right or left comrades in an under tone, but on no account should any remarks be made on the shooting, as such conduct is sure to distract the attention of any one who may be in the act of taking aim.

When about to advance to fire, "shoulder arms," but, in throwing the rifle up to the "shoulder," the greatest care should be taken to prevent it from falling to the ground. With the rifle "shouldered" advance to the firing line, and at the word "ready" make a "half face" to the right, grasp the rifle with the left hand near the lower sight, and bring it down into a horizontal position, with the muzzle pointing to the target; place it on half-cock with the thumb of the right hand, and remove the old cap if the rifle has been recently discharged; place a cap on the nipple, and press it gently but *firmly* down with the thumb; then, with the fingers behind the guard, put the rifle on full cock with the thumb of the right hand, and grasp the small of the butt by placing the thumb round it; fix the eyes

steadily on the object, or bull's eye, and move the right foot back from twelve to sixteen inches (according to the size of the man) farther from the target in a diagonal line towards the right; the right toe pointing to the right, and the left toe towards the target, with both knees straight; raise the rifle slowly until in a line with the object the eyes have fixed on, moving the left hand *well forward;* the rifle resting on the centre of the hand, and not held merely with the finger ends, the thumb stretched along the stock, and the butt in the hollow of the shoulder. If the left hand is moved as far forward as is possible, without occasioning any inconvenience in the posture, the man will find that he can hold the rifle much more steadily to the shoulder. This mode is practised by some of the first rifle shots in the army; the left arm being braced perfectly straight out.

The rifle being placed against the right shoulder, the cheek should be placed on the stock nearly parallel to the wood work, with the head a little bent forward. In this position particular care must be taken to shut the left eye and, in taking aim, to look along the very centre of the back sight, and the top of the front one, to the object aimed at; and, the instant the object is correctly covered, *press* the trigger with the fore-finger.

Too much pains cannot be taken to prevent the rifle from being raised with a jerk, and putting the finger on the trigger before it is at the shoulder; it ought to be deliberately raised, at arms length,

until aligned with the object which the eyes have fixed on, and without too much stooping of the head; for if the body is much bent forward, the man will neither stand so easy nor so steady; and, for this purpose, both heels should be planted firmly on the ground before beginning to raise the rifle.

After firing, "shoulder arms," "right about face," and return to the rank, and load again.

When the specified number of rounds have been completed, and the firing over for the day, the word "attention" should be given, on hearing which, the men must stand at the "order." If they are to be dismissed on the spot, the commands, "shoulder arms," "right face," and "lodge arms," should be given, as this, it will be seen, in the Manual exercise, is the signal for dismissal.

CHAPTER VI.

REMARKS ON LOADING, &c. CONTINUED.

The Charge.—The Bullet.—Ramming Home.—Holding.—Aiming.—Target.—Accidents.—Sights.—Preliminary Practice.—Snapping Caps,

A UNIFORM quantity of powder for each separate charge should be strictly adhered to at all times, and at all distances; great care should, therefore, be taken in its measurement. If the charge is not correctly measured, or any portion of the powder is lost, a corresponding difference in the range will be the result. In making cartridges, the amount of the charge should be calculated to a nicety, and the rifleman when loading, even when in a hurry, should be careful to put in every particle the cartridge contains. If a powder flask be used, see that the charger be always equally full, and that the flask be not shaken more at one time than another in filling the charger.

Some riflemen are so very particular as to weigh each charge separately; placing the powder in paper tubes, containing one charge each; but unless he be as nicely particular with regard to the bullets, and all the manual operations connected with loading, this plan would not be attended with

much advantage. In using the *common* powder flask, unless the man is particularly careful, he may easily make a difference, by the shaking of the flask and the pressure of the forefinger, sufficient to cause an error of a foot or more vertically, at a very short distance, in the flight of the bullet. Of the truth of this he may easily satisfy himself. Take the powder flask and place the finger *gently* on the mouth of it, *shake* the powder well into the charger, and then turn it out upon a piece of paper. Measure another charge, but press the finger *firmly* on the mouth of the charger, and let the powder run into it with *little* or no shaking; turn it out as before, and weigh each charge carefully in a pair of small scales. The result will show that the *shaken* one is the heaviest; the particles having been shaken down closer together; consequently, if the heaviest one is in proportion to the capacity of the barrel, it will propel the bullet with greater force, and cause it to strike the target higher than the other charge, which being less in weight, will have power to do. In pouring the powder into the barrel, the charge should be held as centrical as possible over the bore, so that the grains, in falling, may not adhere to the sides of the barrel.

I may here remark that the mouths of powder flasks, generally, are too wide, as they allow too much of the finger to be pressed in, thereby very materially, and, as I have shown, irregularly, inter-

fering with the correct measurement of the powder. In a windy day, some of the powder is also apt to be blown away from a wide-mouthed flask in the act of loading.

The bullet should never be so large as to require much force to *press* it down, nor should it be too easy; but, whether with paper, or as a *naked* bullet, it ought to fit close, or it will not have the desired effect. When a bullet happens to be so large as to require *hammering* to force it down, draw it at once and throw it away, as a hammered bullet will have ragged edges that will cause it to be much impeded, as well as thrown from its true direction, by the action of the air. When any one is seen, in loading, to hammer the bullet with the ramrod, he may safely be set down as an unscientific rifleman—ignorant of the harm he is doing, or indifferent to the result. If the bullet is too small, it will be apt to "strip," that is, it will pass out of the barrel without taking the *spiral* motion, but if it does not, its range will be less in consequence of a portion of the power of the charge having been permitted to escape in gas between the bullet and the barrel; its true direction will also be affected, either vertically or horizontally, by its being made to lean more to one side of the barrel than another, in the act of loading.

Some riflemen weigh all their bullets separately, and distinguish them into two or three classes: those of which the greater quantity are of an equal

weight, are reserved for fine shooting, and the others are put by themselves for common practice. This is a very good plan; for otherwise, the very best aim may prove at times of no avail, in consequence of some hidden defect in the bullet; for if a part be hollow, the centre of gravity will not be in the line of the axis, and, consequently, its true line of flight will be more or less disturbed.

A very common fault, and a very serious one, is, the placing the bullets down upon the charge of powder lightly at one time, and jamming them down hard at another. This system not only injures the strength of the powder, by caking it, but it most materially affects the flight of the bullet; for it alters its shape, and, thereby, produces resistances from the air, which cause deviations, both vertically and horizontally. It also causes variations in the range; for the initial velocity differs, according as the ramming is more or less violent. By ramming down too hard, besides altering the shape of the bullet, the grains of powder are crushed up, a certain portion is mealed, the due quantity of atmospheric air necessary for thorough combustion is forced out; a greater escape of the propellant gases takes place by the nipple, and, consequently, the strength of the charge, and range of the bullet, is greatly diminished. Those who wish to become good shots, should, therefore, habituate themselves to loading *uniformly;* they should follow the bullet, by a steady *pressure* of the ramrod, to

the bottom; then assure themselves by a moderate pressure, that it rests upon the powder, and that it does so as nearly alike, *every time* as possible.

I have already mentioned that in taking aim, "the left hand should be well forward," its proper place will very easily be ascertained, by the facility with which the rifle can be most steadily kept to the shoulder, so as to preserve it from drooping at the muzzle. The right hand, with the exception of the forefinger, should hold the rifle, clasping it below the trigger guard, and should also assist in keeping the butt firm to the shoulder, being aided in steadying it, in a vertical position, by the inner part of the right arm; and, as the true flight and force of the bullet greatly depends on the rifle being held firm to the shoulder, it is indispensibly necessary not only to press it firmly against the shoulder, but, at the same time, to *resist* as much as possible, but *steadily*, with that shoulder; for the more this steady resistance is persevered in, the less will be the recoil, and, consequently, the greater will be the velocity of the bullet and its range, as a certain amount of propelling force is lost, in proportion as the rifle is permitted to recoil. It should, however, not only be held firm, but at *all times* with an *equal* degree of firmness, until the bullet has left the barrel; and, if possible, for two or three seconds after; as, by so doing, the rifleman will sooner habituate himself to the necessary degree of steadiness, which is absolutely required.

If the butt of the stock is not held in a vertical position, the sights will be inclined to the right or left, which is a fruitful source of bad shooting, especially to new beginners; as some are liable to hold it so more at one time than another. If the rifle is not held with the sights perfectly upright, the axis of the barrel will not be coincident with the line of aim, and, the axis of the bullet being in the same line, it will, as a matter of course, strike the target on the right or left, according as the rifle is canted.

When the rifle is brought up sufficiently high, the cheek should be steadily placed on the stock, with the eye like a fixture, in a line with the sights, so that when brought up to the point intended, the cheek will require no alteration; for if it does, the rifleman will most likely lose the point and be much deceived. At very long distances he will not be so able to apply this rule to practice, in consequence of the greater elevation of the back sight, and the consequent lowering of the butt, but the practice of it at shorter distances, say up to four or five hundred yards, according to the bend of the stock, will beget a steady and uniform habit of holding the head, which will be of the greatest benefit at all distances. At long distances the arms will have to be depressed in proportion as the back sight is elevated, but, in other particulars, the prescribed position must be retained. At very long ranges the rifleman will only be able to rest the *heel* of the butt against the shoulder.

outer men, or compartments, are comparatively bad shots, and count less, the centre square of each counting three, the upper square two, and the lower one. By this it will be seen, that if a hit is to the right or left, it would only score three, or perhaps two, or one; but if the hit were vertically central, if it did not strike the bull's eye, it would at all events score an eight, a seven, or a six; making almost sure to hit a man somewhere, if standing in the same central situation.

In order to ascertain who makes the best shooting, the squares of the target may be reduced to one foot, or six inches, each; and a similar relative value given to each square. For longer ranges the targets must be larger in proportion.

Some who profess to write instructions for riflemen, say, that at 200 yards the practice should be at a single target (six feet high and two feet wide); at 300 yards, it should be at two targets; at 400 yards, at three targets; at 500 yards, at four targets; at 600 yards, at five targets, &c., placed side by side. Now I should never advise such a plan, but rather reverse it, if it were possible; at all events, if I increased the target in width, I would also increase it in height, so as to preserve the square; for those who know anything at all about correct firing, must know that, at 600 or 700 yards distance, a shot may pass a *little* over a target (six feet high), and still be, comparatively, a good shot; whereas, a shot striking the outside

target of five or six, placed side by side, must be considered, comparatively, a very bad shot; as right or left shots are always inferior to shots that strike a little too high, or a little too low.

If, by holding the rifle too long presented at the object before pressing the trigger, the wavering or trembling, to which I have alluded, is felt, the rifleman should not attempt to better his aim by holding it still longer; but at once bring the rifle down from the shoulder, breathe freely, and try again, as it is impossible to fire so true as at a *first* sight. There are times, however, when a man will shoot more unsteadily than at others, if he were ever so carefully inclined; for the slightest derangement of the nervous system would certainly deprive him of the full amount of firmness which is really necessary to produce good shooting. There are also other causes of irregular firing, some of which he may partially obviate, but others he cannot control. To some of these I have already alluded; to others I will direct his attention as we proceed.

After pressing the trigger, the rifleman should continue to look at the object, keeping the rifle immoveable at the shoulder, for two or three seconds, as this will prevent any starting or throwing back of the head, which is often the case in firing; it will also tend to prevent accidents in case the rifle should hang-fire. A skilful and steady shot may always be recognized by his attention to this precaution; and, should his rifle miss fire, he will take

care in picking and cleaning the nipple, to direct the muzzle away from any one, as it sometimes happens that a portion of the percussion powder is left on the nipple, which will, by friction in cleaning, cause the charge to explode. When at practice, *always consider a rifle loaded*, and never point it, or suffer it to be pointed, at any living being; it should always be carried in such a position as not to injure any one, should an accidental discharge take place. The misfortune, in most cases of what are called "gun accidents" is that the offenders do not sin out of ignorance, but from sheer negligence. Ignorance can be instructed, but how shall negligence be cured? When the rifle is capped the half-cock is the position of safety. Should there be occasion to uncock the rifle; in letting the hammer down, it should be suffered to pass beyond the half-cock, and then brought back to it, as by this means it may be heard, as well as felt, to *tell* into the notch of the tumbler, and thus be rendered perfectly secure: great care should be taken, at the same time, that the muzzle of the piece be kept as erect as possible, which will prevent mischief, supposing by accident the hammer should slip from the thumb, and thus discharge the rifle.

If the sights are not correctly placed, the line of aim will not be in the same vertical plane with the axis of the barrel; and the aim so taken will not carry the bullet in the true line of vision, but always to the right, or to the left. If this is found

to be the case, let the back sight be fitted like a fixture fairly on the barrel; then move the front one to the right or left, in such a way that the line of sight thus arranged shall be in the plane of fire or vertical plane; that is, if the bullets strike to the right of the mark, move the front sight a little to the right; but if they strike to the left, move the front sight a little to the left. When the front sight has been found to be correctly placed, make a mark on it, and a corresponding one on the barrel; so as to be able to tell at a glance, if the sight shifts in the slightest degree, during the time of firing.

As a preliminary practise, I would recommend young beginners to aim at a small mark, and press the trigger, with caps only, as the smoke from the discharge prevents young riflemen from seeing whether they shake the muzzel or not in firing. This exercise is excellent for forming good marksmen; and, besides the saving of ammunition, it has the recommendation of being easily resorted to at any time, and in any weather, by setting up a mark in a garden or court yard. The nearer to the mark the smaller it must be. Recruits may even resort to this sort of practice in a room, by fixing a small red, or black, wafer on the wall at one end, and taking their stand at the other. By repeating this exercise until they have attained a perfect steadiness in position, *before*, *during*, and *after* pressing the trigger, and can accomplish it without *winking*, *starting*, or *shaking* the muzzle of the rifle, they will have

attained a confidence and command over themselves and their rifles that will be of the very greatest advantage to them on ball-practice days; for those who are able to snap caps while aiming at a mark, and retain a perfect *immobility* of body, may be looked upon as likely to prove in due time, excellent marksmen in the field.

CHAPTER VII.

CAUSES OF IRREGULAR FIRING.

The Recoil.—The Wind.—The State of the Atmosphere.—The Position of the Sun.

THE *Recoil* is the motion which the explosion of the powder communicates to the charge. The direction of this motion is opposed to that of the bullet, and has a tendency to throw the firer out of line, making him, in a slight degree, wheel round; the deviation produced being, at the same time, partly vertical, and partly horizontal.

When the powder is suddenly inflamed at the bottom of the barrel, it necessarily exercises an action two ways at the same time; that is to say, against the breech of the piece, and against the bullet, that is placed above it. Besides this, it acts also against the sides of the barrel which it occupies; and as they oppose a resistance almost insurmountable, the whole effort of the elastic fluid produced by the inflammation is exerted in the two directions above mentioned. But the resistance opposed by the bullet being much less than that opposed by the breech of the barrel, the bullet is forced out with great velocity. It is impossible, however, that the body of the piece itself should

not experience a movement backwards; for if a spring is suddenly let loose, between two moveable obstacles, it will impel them both, and communicate to them velocities in the inverse ratio of their masses; the piece, therefore, must acquire a velocity backwards nearly in the inverse ratio of its mass to that of the bullet. The term *nearly* is made use of, because there are various circumstances which give to this ratio certain modifications.

The *force* of the recoil depends on the *charge of powder*, the *weight of the bullet*, the *weight of the rifle*, and, more particularly, on the amount of *friction* which the bullet experiences in passing up the barrel. By augmenting the charge in certain proportions, the recoil is increased—the quantity of gas produced by the explosion becoming more considerable; if the charge is diminished, the recoil is lessened. The *least* quantity of powder that is found to act satisfactory should, therefore, be fixed on as the charge, and adhered to. The *weight* of the bullet has also an influence on the recoil; for the obstacle opposed to the expansion of the powder gases is the more powerful in proportion as the bullet is heavier. The force of the recoil, which depends on the action of these gases on the hinder part of the barrel, will therefore be augmented, if the weight of the bullet be increased. If the *windage* is lessened, the recoil will be augmented, as a smaller quantity of gas will escape between the bullet and the

barrel. The *fouling*, which diminishes the windage and increases the friction of the bullet against the sides of the barrel, will also, as I have already remarked, augment the recoil. The method of loading and driving home has, besides, a great influence on it. If the *breadth* of the lands of the rifle is reduced to a maximum, the friction of the bullet will also be reduced, and so will also the recoil; for, as the bullet will proceed with greater velocity, and, consequently, with less retardation in the barrel, the *reaction* against the breech will be less.

The heavier the rifle, the less will the recoil be felt, as the same force will communicate less velocity to any body in proportion as the weight of that body is increased. When the person firing, therefore, is careful to keep the rifle firmly fixed against his shoulder, he and the rifle almost become one body—the rifleman and the rifle receive, in some measure, the motion of the recoil together; while on the other hand, if the rifle does not touch the shoulder, or only presses gently against it, the rifle strikes this part of the body with an energy proportionate to the rapidity of the motion it has received. The motion of the recoil has for its direction the axis of the barrel; if the stock were, therefore, straight, so as to prolong this axis, the person firing would experience the whole force of the recoil, but the stock being bent, in order to facilitate the aim, the rifle loses its tendency to recoil; the effect of this bend, however, if it tends

to lessen the recoil of the piece when resting against the shoulder, tends also to throw the muzzle up, by making it turn, as it were, on its fulcrum at the bend, although the arms are, or ought to be, employed to resist this action; the left hand being well stretched out along the stock.

The use of too fine powder is also the cause of a very unpleasant and dangerous recoil; as the compressed air in the fore part of the barrel exerts a resisting influence against the charge, which is not of a sufficiently graduated expanding quality for the capacity of the barrel; there being a greater column of air in the barrel than the explosive fluid is able to displace, as it would do, if the powder were of a larger grain.

Having alluded to causes of irregular firing, which by care and attention may be rectified, I shall now take notice of others over which the rifleman can have no control, but which, by careful observation, he may render less injurious to his firing, than they might otherwise be.

The first is the effects of the *wind* upon the flight of the bullet. When the wind is blowing from a quarter exactly opposite to the direction of the bullet, the latter will experience a greater resistance, and be proportionally lowered; the muzzle of the rifle must, therefore, be proportionally raised in order to hit the mark. When the wind is blowing in a line exactly with the direction of the bullet, it does not add to its velocity, but it allows it to be greater, by causing the air to move in

the same direction; rendering its *ordinary resistance* to the bullet weaker; the bullet thus rises in the plane of projection, and strikes higher; the muzzle of the rifle should, therefore, be proportionally lowered. When the wind blows from a quarter which forms an angle to the direction of the bullet, that is to say, from either side, the bullet is carried to the opposite side from whence the wind blows, and the more so the nearer the wind blows from a right angle. A very important point in connexion with the wind, is to recollect that the more that the target is distant, the greater the deviation will be, as the bullet remains subject to its action for a greater length of time; and, also, that the deviation will be still more as the force of the wind is greater. The aim must, therefore, be more to the side from whence the wind blows, in proportion to the force of the wind, and the distance the man is firing.

It is very easy, I admit, for me to direct any one to aim a little higher, a little lower, a little to the right, or a little to the left; for this is a very uncertain mode of taking aim, and requires great practice in all kinds of weather, and at all distances; and even then, a sudden gust of wind may strike the bullet on its passage, and completely upset the nicest calculations. The rifleman must, therefore, be careful, in making any compensation, as it is called, not to venture too far with his aim from the bull's eye, until he has had sufficient experience.

The next is the ***state of the atmosphere*** on practice days. When the temperature is high, the density of the air is less, and the resistance it opposes to the bullet is weaker; the bullet rises, and, consequently, the range will be somewhat longer; in order, therefore, to hit the mark, the muzzle should be proportionately lowered according to the distance. When the temperature is low, the density of the atmosphere is greater, and, as its resistance will be more, the range of the bullet will be somewhat less; the muzzle should therefore, be proportionately raised. Every change in the temperature, by varying the density of the air, changes the form of the trajectory, and, elevates or depresses the bullet, but without causing it to quit the plane of projection. The temperature and humidity of the atmosphere have, besides, a great influence on the rapidity of the inflammation of the powder and the force it developes at the moment of explosion.

The ***position of the sun*** is also sometimes the cause of irregular firing, by rendering the true line of sight more uncertain. When the sun is on the right, the right side of the front sight appears bright, while the left side is thrown into shade; an inverse effect is produced on the notch, if the back sight has one, for the right side of the notch will be in the shade, while the left side will appear bright. A bright spot will, therefore, be seen on the left side of the notch of the back sight, and the right side of the front one, which will attract the

attention of the firer, and lead him to aim by directing on the object a line of sight passing on the left of the centre of the notch of the back sight, and the right of the front one; the effect of which will be that the axis of the barrel will be inclined to the left, and the bullet will, consequently, strike on the left side of the target. When the sun shines on the left the effect will be exactly the reverse; therefore, the only remedy for this cause of deviation is to aim a little to the right when the sun is on the right side, and a little to the left when the sun is on the left side. The breech sight, however, which I have contrived, and described in Chapter IV, is a remedy for these evils.

Chapter VIII.

ON GENERAL PRACTICE.

The intelligent Skirmisher.—The power of doing injury to a Foe at the greatest distance.—Various Positions.—Firing at moving objects.—Up and Down Hill.—External and Internal causes of Deviation.—Judging of distances.—By the apparent height of the Marksmen.—The Stadia, &c.

"The life and especial mark of a good skirmisher," says Colonel Gawler, "is *Active intelligence*. In the ranks, the closer men attain to a state of unreflecting mechanism, with nothing of mind but attention, the nearer they are to true soldier-like perfection. Not a thought should arise, an eye-ball turn, or a finger tremble, but in obedience, and that obedience should be accurate and instantaneous as the word. Not so the skirmisher; within certain limits he is his own general, and must think for himself. From the moment that he shakes out from the elbows of his right and left comrades, reflection must awake, and, in due dependence on a broad established system, every man should manœuvre as if the fate of the day depended upon his own conceptions.

"The mechanical stiffness, formerly much seen in British Light Infantry, arose, there can scarcely be a question, from the formality of our old ordinary mode of applying the system of Light Infantry drill. The automatonism, proper to the ranks, was extended to skirmishers, and they also were taught to move only as they were wound up. The indignation of the drill instructor was poured out, *not* upon men who failed in the first rate essentials of good skirmishing, but upon those who erred a foot in dressing or in distance—who did not step off, halt, or fire, precisely at the sound of the whistle or elevation of the signal firelock—whose unmusical ears refused to distinguish amid the endless variety of bugled orders—who could not run like racers, or who ran bewildered in some of the intricate evolutions, which were supposed to crown the very pinnacle of skirmishing perfection. Some corps did not drill according to this erroneous method, others did not carry it to its full extent; but, taking the army as a whole, unreflecting precision, in the details of skirmishing was its system."

The immense importance of very great attention to the ball-practice of this branch of the service, is too obvious to require an enforcing observation. It is not the case that careful firing is provoked by the sight of an enemy; on the contrary, arithmetical calculation has repeatedly proved, to the blush of the good soldier, that under no circumstances are balls so wildly and carelessly thrown

away as in those moments when the fortunes of empires are thrown away along with them. To enable the volunteer to become an efficient rifleman, his practice ought to be of the most varied character. Soldiers of the line are trained at ranges from 150 up to 900 yards; but the rifleman should be trained at all ranges up to the highest effective range of his rifle, for the express purpose of picking off artillerymen and horses, and reconnoitering parties; or for annoying columns under or forming for attack; for at all such ranges every bullet from a well-made rifle, in properly trained hands, would tell. All manner of positions should be assumed—*the upright posture becoming an exception, rather than a rule*—for it is not what the *man* can do, but what the man can make his *rifle* do,—the power of doing injury at the *greatest* distance being as I have already said, the *primary* consideration; the rifleman should, therefore, assume that position which may appear to him, at the time, as likely to prove the most effective.

The upright position is useful; it should be known by all, and the men be able to assume it with facility; but the kneeling position is to be preferred, as regards firmness and steadiness. It allows aim to be taken much more surely than in the erect posture; and as it fatigues the left arm much less than the latter does, it furnishes the power of firing a much greater number of rounds with effect. To attempt to fire from the shoulder,

at *long* ranges, in an upright position, would be throwing away ammunition, so long as a stump of a tree, a stone, or any irregularity in the ground offered a *support* to make the aim more certain. A new kneeling position has been introduced, which gives the rifleman greater steadiness in taking aim. The position is this: the man kneeling on the right knee sits on the right heel, while the left elbow rests on the left knee, the left hand steadying the rifle. The body thus rests on a tripod of equilateral proportions, of which the right knee, right toe, and left foot are the feet, and this position is generally found easy and advantageous. It is also a very good plan to plant the rifle sword in the ground, and, kneeling low down, to rest the barrel on the hilt, and then take a steady aim.

A practical rifleman assumes and quits the kneeling position with great rapidity, and, on *level* ground, it furnishes this advantage, that he exposes only half his body, at the most, to the shot of the enemy. *Any* position, however, that affords the best *additional* support to the rifle, must be considered as the best position for the rifleman who wishes to acquire a precision, a sort of perfection in firing at long ranges, which the upright position will never give him. At all *matches*, therefore, from 300 to 1000 yards, or more, a *rest* should be allowed, for it is the *fine* shooting, not the random shots, that creates the greatest interest at all such meetings.

To hit an object *moving* in a direction perpendicular, or nearly so, to the firing plane, it is requisite to aim by so much in front of it, in the direction it follows, as the velocity of the motion is greater or less, and as it is nearer or more distant. It is indispensable not to fire till the object has been followed for some time, in order to arrive at a full comprehension of the direction and the velocity of the motion. If the object approaches the person firing, the muzzle of the barrel should be gradually and gently lowered, with the finger on the trigger all the while; if, on the other hand, the object is retiring, the muzzle of the barrel should be gradually raised, and more or less quickly, in proportion to the velocity of motion of the object. In general, the quantity by which we should aim higher or lower than the estimated distance would require, at an object approaching or retiring, depends on the rapidity of the motion, and the increase in the remoteness of the object.

In the rules for firing, which have been given, it has generally been assumed that the line of sight is horizontal, or very slightly varying from that direction. When the mark and the party firing are not on the same level, and the difference is very preceptible, the form of the trajectory of the bullet is altered; so that if the ordinary rules for firing were followed, it would not be possible to hit the mark. It may be seen, by means of a geometrical figure, that, when the line of sight is inclined above the horizontal, the trajectory is less

curved than is the case when the line of sight is horizontal, and that, on the contrary, the trajectory is more curved when the inclination takes place below the horizontal. It will be necessary, then, to aim above the point at which we should fire on level ground, in order to hit an object placed at an elevation, and below it, if the mark to be hit is situated on lower ground.

To hit a target one foot square, *every* time, at 100 yards, may be considered very good practice for the generality of riflemen; but to hit a target ten feet square, every shot, at 1,000 yards, must be allowed to be very superior shooting. At *short* ranges the bullet has the greater part of its original velocity within itself until it reaches the target; the disturbing atmospheric influences have, therefore, comparatively little effect upon it; nor does any slight irregularity, in the holding of the rifle, affect it perceptibly; but at *long* ranges the deflection is very apparent, and often astonishes the marksman who has not studied the cause. In firing at 1,000 yards, the original velocity of the bullet is reduced, by the resistance of the air, to less than a third of what it was when it left the barrel, before it has reached much more than two-thirds of that distance; the deflecting agency of currents of air have, therefore, great power near the end of a long range, and are capable of producing a manifest lateral effect upon the bullet, and these changes are more marked as the distance is increased, and the velocity of the bullet lessened.

Besides, if the rifle is not held so as to preserve the *back* sight *truly perpendicular* with the axis of the barrel, the bullets will go to the left if the sight itself is inclined to the right, and *vice versa*, and it is worthy of remark, that the very *slightest* inclination will cause a deflection of many yards before the bullet reaches the target at long ranges.

All *external* causes of deviation increase with the distance, but in a much greater proportion; as the deviating force becomes more powerful as the velocity of the bullet becomes weaker. *Internal* causes of deviation are various; a rifle may shoot very well at 100 or 200 yards, and "not shoot at all" at 1,000; this can only be accounted for by some peculiarity in the barrel, in the mode of grooving, in the degree of spiral, or in the bullet itself, and can only be discovered, on close examination, by a competent judge.

Rifle firing, in many of the circumstances of war, may be effected in the same manner as on the practice ground. The Rifleman will not always be able to select an individual at whom to fire in the enemy's line, either in consequence of the smoke, or the manœuvres which may mask and cover a portion of this line; but it will generally be possible for him to aim at his ease, without any obstruction, at *whole lines* or *masses*, which the conditions under which he fires will give him every opportunity of reaching. In this species of firing, as well as in the others, indeed, the proper *appreciation of distances* is indispensable.

The great importance to a rifleman, of being able to estimate distances correctly, may be very readily conceived. In firing at the target, simply for practice, the distances are well known, and nothing is required but to arrange the slide of the back sight, to aim correctly, and to fire with care and attention; but it would be otherwise when opposed to an enemy in the field, where the distance would be necessarily unknown, and where the rifleman would be required to decide with promptitude, and as exactly as possible, the distance, and regulate his firing accordingly. This can only be accomplished by continual practice and observation, as that alone can impart a species of precision, an accuracy to the eye, which permits the measurement of long distances sufficiently exact for the purposes of the rifleman.

By careful observation and attention the rifleman may render his ordinary target practice of great use in judging of distances, he has only to keep in mind the *apparent* height of the markers as they move to and fro. By carefully studying their apparent height from the different distances he fires, he may learn to measure with the eye, with tolerable certainty, the distance he is from a man; and acquire that readiness and quickness in deciding upon it, that is so essential in making expert marksmen. A still more efficient mode of practice may be adopted, by having a target, the size of a soldier, placed in

unusual parts of the ground, and the rifleman marched to different and uncertain places to fire from.

In damp and hazy weather, the objects, being less lighted, will appear more remote than they really are. In fine weather and sunshine, the objects standing in a strong light, will appear much nearer than they really are. The appreciation of distance in an avenue of trees is difficult, for, the perspective is very deceptive, and causes objects to appear at a much greater distance than they really are.

There are scientific instruments of various descriptions manufactured for the purpose of measuring distances; the most simple and easy of application, is called a *stadia;* but none of them are likely to become general in actual warfare. Up to 500 yards, the *stadia* might be of considerable service to an officer commanding a party; but beyond this distance it is very difficult to employ it with exactness, in consequence of the insignificance of the apparent heights, and the difficulty of clearly tracing the outline of the objects.

The distance of infantry or cavalry may be measured by a telescope, with a micrometer scale in the eye piece.

PART II.

CHAPTER I.

ON RECRUIT OR SQUAD DRILL.

Lieutenant-General Sir Charles Napier on Volunteer Drill.—The Duties of a Volunteer Adjutant secondary to those of the Instructor of Musketry.—Prefatory Remarks.—Position of the Recruit.—Standing at Ease.—Attention.—Dressing.—Facings.—Position in Marching.—Quick Step.—Stepping out.—Stepping short.—Marking Time.—Double March.—Side or Closing Step.—Wheeling.—Diagonal March.—File Marching.

LIEUTENANT-GENERAL SIR CHARLES NAPIER, in his celebrated letter "on the Defence of England, by Volunteer Corps," says, "Get some old Soldier for your Adjutant to teach you, not a long course of drill, but just seven things, viz.:—

1. To face right and left by word of command.
2. To march in line and in column.
3. To *extend* and *close* files as Light Infantry, with "*supports*."
4. To change front in *extended* and in *close* order.
5. To relieve the Skirmishers.
6. To form *solid* squares and *rallying* squares.
7. To form an advanced guard.

"These seven things," he continues, "are all you require; do not let any one persuade you to learn more."

The above course of drill is admitted to be quite sufficient for any but professional soldiers. Indeed, when entered into, it will be found to comprise far more than it did when General Napier wrote his letter (February, 1852), as little or nothing was then known of the power and range of the weapon which has since so completely revolutionized the relative value of the different arms, and the mode of conducting skirmishing manœuvres in the field. At that time Sir Charles admitted that he had not even seen one of the new rifles, so that his recommendation to get some old Soldier for an Adjutant must in some measure be qualified, as the *mere* "old Soldier," who is *unacquainted* with gunnery, as applied *scientifically* to the modern long-range rifle, cannot be a qualified instructor of Volunteer *Riflemen*, whose value, in the hour of danger, will depend more on their *skill* in the *use* of that weapon, than on any knowledge they may acquire of Light Infantry movements. In fact, marching and manœuvring, and the ordinary duties of an Adjutant, must merge into or become secondary to the more scientific and laborious duties of the Captain Instructor of Musketry: for though a limited amount of drill, and some knowledge of skirmishing, will be absolutely necessary, still the "crack" corps of British Volunteers will be those that can put the greatest number of shots into the target at the

longest ranges, as the *target* and the target only, will become the measure of their efficiency, usefulness and distinction.*

The great object is not to make amateur soldiers, but *skilled riflemen;* not to produce a few hundred imperfect battalions, but thousands upon thousands of trained and unfailing sharpshooters. Once more in the history of this nation we are to adopt a *national* arm, to take it up with a will, to teach ourselves and our children its use, and to make it our trusty and familiar weapon, until the British rifle shall become as renowned and as formidable as the English long-bow. That is the great object of the present movement. It is easy enough to form a "Volunteer Corps," to select a uniform, to enjoy a pleasant field day, and to indulge that military spirit which, after all, is ingrained in the very nature of Englishmen. All this we can do as our ancestors did, with as much alacrity and as heartily, but we must do something more. We must go seriously to work till we can really call ourselves *rifle-shots,* and when that is done a Volunteer Corps will be as good, for home defence, as the best regiment in the world. A few of the simple movements which enable men to act in large bodies and

* The truth of these remarks has since been confirmed by high authority, for "on the 1st of July, the Secretary of State for War said, in reply to a question from Sir J. Shelley, that twenty-five Adjutants and 100 Serjeants of the disembodied Militia are about to repair to Hythe to become qualified as Instructors in Musketry, and will then be available for Volunteer Corps."

obey orders in the field may be learnt without difficulty. That kind of practice is soon mastered, and may also be superintended by the Instructor of Musketry, but the *real* drill must be drill of another kind. Every man of every corps ought to be sure that within a certain distance of his rifle no enemy could stand and live. That will be the true test of "*effective*" volunteers. When once they have learnt to use the rifle, as modern rifles *can* be used, the mere organization of the millions which these Islands can produce, will be, comparatively, a work of the greatest ease.

The instructors to whom the drilling of recruits is intrusted, should be clear, firm, and concise in their mode of conveying instruction, in order to command attention to their directions. Short and frequent drills are always to be preferred to long lessons, which exhaust the attention of the teacher as well as the pupil. Recruits should not, therefore, be kept too long at any particular part of their exercise, and, for thc sake of greater variety, the lessons contained in this chapter and the next may, with great propriety, be intermixed. It will also encourage attention, if the men are moved on progressively from class to class according to their merit, so that the quick intelligent volunteer may not be kept back by those of inferior capacity. A system of mutual instruction may likewise be introduced with much advantage, as the more forward would be able to drill small squads in outlying districts, where the members would be too far

removed for constant attendance on the regular Head Quarter drills. In conclusion, as *smartness* is a first-rate military quality, Instructors should be careful to impress this fact on the minds of all, that to perform the necessary movements with *grace*, and *ease*, instead of getting into a slovenly and careless habit, requires only a little *extra* attention, on the part of the volunteer, at the commencement.

Recruits are generally instructed at the outset by placing several together in what is termed

Single Rank at Open Order.

This is taken by each man stretching out his right arm and keeping that distance from his right-hand man, but as the following instructions are intended for a class superior to the generality of recruits, it is deemed advisable to proceed at once, under the supposition that a similar number of men are placed together in what is called

Single Rank at Close Order.

In a "Single Rank at *Close* Order," the *Touch* constitutes the principal guide and regulator in its formation; for each man, when properly in line, should feel his right, or left, hand man (towards the point of direction) at the thick part of the arm immediately below the elbow; but the *Touch* should be very light, so that crowding together may be carefully avoided.

Sec. 1.—Position.

The shoulders and body should be square to the front. The heels in a line and close together. The

knees straight. The toes turned out, so that the feet may form an angle of 60 degrees. The arms hanging close to the side. The elbows turned in, and close to the body. The hands open, the palms turned flat to the thighs, and the elbows close to the sides. The thumbs close to the forefinger, and as far back as the seams of the trousers. The breast advanced, and the belly drawn in, but without constraint. The head erect. The eyes straight to the front. The knees pressed back. The body upright, but inclining forward, so that the principal weight may bear on the fore part of the feet.

This is the position in which the man is expected to place himself when the word ATTENTION is given.

Sec. 2.—STANDING AT EASE.

On the words STAND-AT-EASE, the left foot is carried forward six inches, toes to the left front, feet separated, the greatest part of the weight of the body brought upon the right leg; the left knee a little bent: the hands brought together before the body, the palms struck smartly together, that of the right hand slipped over the back of the left, dropping them to the full extent; the shoulders kept back and square; the head to the front, and the whole attitude without constraint.

On the word ATTENTION, the hands fall smartly upon the outside of the thigh; the left heel is brought back in a line with the right, and the proper unconstrained position immediately resumed.

If the command STAND-AT-EASE is followed by the words STAND EASY, the men are permitted to move their limbs, but without quitting their ground, so that upon the word ATTENTION, no one shall have materially lost his *dressing* in line.

Before calling men to Attention, when they are standing easy, the caution EYES-FRONT is given, upon which every man resumes his position as described in STAND-AT-EASE, and remains steady.

Sec. 3.—DRESSING.

On the word DRESS, each individual casts his eyes to the point to which he is ordered to dress, with a slight turn of the head, but preserving the shoulders and body square to the front; when, if properly *dressed* (or in line), each man will just be able to distinguish the lower part of the face of the second man beyond him; but if not properly dressed, very short quick steps, forwards or backwards, must be taken to gain exactly the proper position.

If the word *Dress* is given singly, without naming any point by which to dress, the men must turn their heads to the flank from whence the voice proceeds.

Sec. 4.—EYES TO THE RIGHT, LEFT, OR FRONT.

On the words EYES-RIGHT, glance the eyes to the right with a slight turn of the head. On the words EYES-LEFT, cast the eyes in like manner to the left; and on the words EYES-FRONT, the

look and head must be turned directly to the front.

These motions of the eyes are useful on the *wheeling* of divisions; in closing to a flank; or when *dressing* is ordered after a *halt.*

Sec. 5.—Facings.

In going through the *facings*, the left heel is never to quit the ground. The body must rather incline forward, and the knees be kept straight.

To the Right Face.

1st. Place the hollow of the right foot smartly against the left heel, keeping the shoulders square to the front.

2nd. Raise the toes, and turn a quarter circle to the right on both heels, which must be kept close together.

To the Left Face.

1st. Place the right heel against the hollow of the left foot; keeping the shoulders square to the front.

2nd. Raise the toes, and turn a quarter circle to the left on both heels, which must be pressed together.

Right about Face.

1st. Place the ball of the right toe against the left heel, keeping the shoulders square to the front.

2nd. Raise the toes, and turn to the right about on both heels.

3rd. Bring the right foot smartly back in a line with the left.

Left about Face.

1st. Place the right heel against the ball of the left toe, keeping the shoulders square to the front.

2nd. Raise the toes, and turn to the left about on both heels.

3rd. Bring up the right foot smartly in a line with the left.

Right (or Left) Half-face.)

1st. Draw back (or advance) the right foot one inch.

2nd. Raise the toes, and turn an eighth of a circle to the right (or left) on both heels.

This facing is necessary when it is intended to perform the diagonal march to the front.

When it is necessary to perform the *diagonal* march to the rear, the words Right (or Left) about, three-quarters face will be given, upon which the ball of the right foot (not the ball of the toe) is brought to the left heel, or the right heel to the ball of the left foot; then make a three-quarters face in the given direction, and square the heels.

Front.

When it is intended to resume the original front, the word of command Front will be given, when the whole face the nearest way to the front, except when faced to the rear, then always by the right.

The foot in the first of the above motions should be carried back or brought forward without a jerk; the movement being from the hip, so that the body is kept perfectly steady until faced.

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In going through the *facings*, the left heel is never to quit the ground. The body must rather incline forward, and the knees be kept straight.

To the Right Face.

1st. Place the hollow of the right foot smartly against the left heel, keeping the shoulders square to the front.

2nd. Raise the toes, and turn a quarter circle to the right on both heels, which must be kept close together.

To the Left Face.

1st. Place the right heel against the hollow of the left foot; keeping the shoulders square to the front.

2nd. Raise the toes, and turn a quarter circle to the left on both heels, which must be pressed together.

Right about Face.

1st. Place the ball of the right toe against the left heel, keeping the shoulders square to the front.

2nd. Raise the toes, and turn to the right about on both heels.

3rd. Bring the right foot smartly back in a line with the left.

Left about Face.

1st. Place the right heel against the ball of the left toe, keeping the shoulders square to the front.

2nd. Raise the toes, and turn to the left about on both heels.

3rd. Bring up the right foot smartly in a line with the left.

Right (or Left) Half-face.)

1st. Draw back (or advance) the right foot one inch.

2nd. Raise the toes, and turn an eighth of a circle to the right (or left) on both heels.

This facing is necessary when it is intended to perform the diagonal march to the front.

When it is necessary to perform the *diagonal* march to the rear, the words Right (or Left) about, three-quarters face will be given, upon which the ball of the right foot (not the ball of the toe) is brought to the left heel, or the right heel to the ball of the left foot; then make a three-quarters face in the given direction, and square the heels.

Front.

When it is intended to resume the original front, the word of command Front will be given, when the whole face the nearest way to the front, except when faced to the rear, then always by the right.

The foot in the first of the above motions should be carried back or brought forward without a jerk; the movement being from the hip, so that the body is kept perfectly steady until faced.

look and head must be turned directly to the front.

These motions of the eyes are useful on the *wheeling* of divisions; in closing to a flank; or when *dressing* is ordered after a *halt*.

Sec. 5.—Facings.

In going through the *facings*, the left heel is never to quit the ground. The body must rather incline forward, and the knees be kept straight.

To the Right Face.

1st. Place the hollow of the right foot smartly against the left heel, keeping the shoulders square to the front.

2nd. Raise the toes, and turn a quarter circle to the right on both heels, which must be kept close together.

To the Left Face.

1st. Place the right heel against the hollow of the left foot; keeping the shoulders square to the front.

2nd. Raise the toes, and turn a quarter circle to the left on both heels, which must be pressed together.

Right about Face.

1st. Place the ball of the right toe against the left heel, keeping the shoulders square to the front.

2nd. Raise the toes, and turn to the right about on both heels.

3rd. Bring the right foot smartly back in a line with the left.

Left about Face.

1st. Place the right heel against the ball of the left toe, keeping the shoulders square to the front.

2nd. Raise the toes, and turn to the left about on both heels.

3rd. Bring up the right foot smartly in a line with the left.

Right (or Left) Half-face.)

1st. Draw back (or advance) the right foot one inch.

2nd. Raise the toes, and turn an eighth of a circle to the right (or left) on both heels.

This facing is necessary when it is intended to perform the diagonal march to the front.

When it is necessary to perform the *diagonal* march to the rear, the words Right (or Left) about, three-quarters face will be given, upon which the ball of the right foot (not the ball of the toe) is brought to the left heel, or the right heel to the ball of the left foot; then make a three-quarters face in the given direction, and square the heels.

Front.

When it is intended to resume the original front, the word of command Front will be given, when the whole face the nearest way to the front, except when faced to the rear, then always by the right.

The foot in the first of the above motions should be carried back or brought forward without a jerk; the movement being from the hip, so that the body is kept perfectly steady until faced.

Sec. 6.—Position in Marching.

In marching the men should be well balanced on their limbs. The hands kept steady, but not to cling or move with the thigh. The legs to move from the haunches, free and natural. The feet, being raised sufficiently high to clear the ground without grazing it, carried straight to the front, and, without being drawn back, placed softly on the ground, so as not to jerk or shake the body, the toes turned out at an angle of thirty degrees. The body square to the front, the head erect, and the eyes directed straight forward.

The flank towards which the men are ordered to *touch*, is called the Pivot flank, the opposite flank is called the Reverse flank. Before a squad is ordered to march the pivot flank should be decided by the caution, *By the right*, or *By the left.*

Marching always commences with the left foot, except the *side step* to the right.

Sec. 7.—The Quick Step.

The pace called, in the regular army, the *Slow Step*, should be unknown in Volunteer Rifle Corps, it will, therefore, be desirable to proceed at once to the *Quick Step*.

Quick time is 108 steps in a minute, each thirty inches in length, which gives ninety yards in a minute, or three miles and one hundred and twenty yards in an hour.

The word Quick is to be considered as a caution, and at the word March, the whole move off,

conforming to the directions given in the last section.

Sec. 8.—The Halt.

On the word Halt, the foot which is off the ground is to complete the step; then square the heels, and stand still, thus finishing the step which was being taken when the word of command was given.

After the word Halt, the men should stand perfectly steady, in whatever position they may be, unless ordered to *Dress*.

Sec. 9.—Stepping Out.

Supposing that the men are marching, as already directed in *Quick Time*, on the words Step Out being given, each man lengthens his step from 30 to 33 inches, by leaning forward a little, but without altering the *time* taken to complete each step.

This step is necessary when a temporary exertion to the front is required; but at the words Quick Step, the pace of 30 inches is again to be resumed.

Sec. 10.—Stepping Short.

On the words *Step Short*, the foot advancing is to finish its pace, and afterwards each man takes paces of 10 inches until the word *Forward* is given, when the usual pace of 30 inches is to be resumed.

This Step, and ***Marking Time***, are useful when a momentary retardment of a body of men is required, or when a division has to wait for others coming up.

Sec. 11.—Marking Time.

On the words Mark Time, the foot advancing is to complete the pace, after which the same time, or cadence, is to be continued, without gaining ground, by alternately moving the feet up and down, without bending the knee too much. At the word Forward, the usual pace of thirty inches is to be taken.

Sec. 12.—Stepping Back.

On the words Step Back, Quick March, the men move straight to the rear, preserving the shoulders square to the front, the head erect, and taking the full pace of thirty inches. On the word Halt, the foot in front must be brought back square with the other.

This step can only be necessary when a few paces are required to the rear.

Sec. 13.—Changing Feet.

When it is necessary to change the feet in marching, the advanced foot must complete its pace, the ball of the rear foot is then to be brought up quickly to the heel of the advanced one, which is instantly to make another step forward; taking,

as it were, two successive steps with the same foot, at the same time preserving the true cadence.

This movement is required to be performed by any man who is stepping with a different foot from the rest of his division.

Sec. 14.—The Double March.

Double Time is 150 steps in a minute, each thirty-six inches or one yard in length.

On the words Double March, the whole step off together; the knees a little bent; the body more advanced than in the other marches, and the arms hanging with ease down the sides.

The full pace of thirty-six inches must be taken, to avoid getting into the habit of a short trot, which would defeat the object of this step.

The men should be taught to *Mark Time* in the *Double March* in the same manner as in the *Quick Step*.

Sec. 15.—The Side or Closing Step.

The *Side* or *Closing Step* is to be performed from the *Halt* in quick time, as follows :—

On the words Right Close, Quick March, the eyes are to be turned to the right, and each man is to carry his right foot to his neighbour's left foot, till the heel touches his right heel; then take the next steps in the same manner.

The whole must do this with perfect precision of time, keeping the shoulders square, the knees not bent, and in the true line on which the body is formed.

At the word HALT, the whole halt, turning their eyes to the front, and remain steady.

The *Left Close* is to be performed in the same manner, by turning the eyes to the left, and moving the left foot to the next man's right foot.

In *Closing* on rough or broken ground, the men are necessarily permitted to bend their knees.

The men should also be practised in taking any given number of paces to either flank, and then halting without word of command: the command to be given thus, THREE PACES RIGHT CLOSE, QUICK MARCH.

Sec. 16.—WHEELING FORWARDS A SINGLE RANK FROM THE HALT.

On the words RIGHT WHEEL, the right hand man faces to the right, and, on the words QUICK MARCH, the remainder step off together, the whole turning their eyes to the left (the wheeling or outward flank) except the left-hand man, who looks inwards, and steps the usual pace of thirty inches. The others looking outwards, but touching inwards, keep the same time, but shorten their pace, in proportion as they are nearer to the right hand man on which the wheel is made, so as to bring their left hand man round with them, without pressing too much upon one another, or losing the touch.

On the words HALT-DRESS, the whole halt, and *Dress*, keeping the touch towards the right hand man.

On the words EYES FRONT, the whole turn their eyes to the front, and remain steady.

In *wheeling to the left*, the left hand man faces to the left, the whole observing the same instructions given for *Right Wheel*, but reversed.

Sec. 17.—Wheeling backwards a Single Rank.

At the caution, ON THE RIGHT, BACKWARDS WHEEL, the right-hand man faces to the left. At the words QUICK MARCH the remainder step backward, looking and touching the same as in wheeling *forward on the right.*

In wheeling *backwards on the Left*, the left hand man must face to the right, and the remainder step backward, looking and touching as in *wheeling forward on the Left.*

No rank, nor ranks of more than twelve files should ever be wheeled backwards; they should be faced about and then wheel forwards.

Sec. 18.—Changing the Direction by Wheeling on a Moveable Pivot.

When the rank is marching to the front, and is required to change its direction, the words RIGHT (or LEFT) WHEEL, will be given, when the wheel is to be performed as directed in the last two sections, with the exception that the pivot man *marks time*, and brings his shoulder round with the others, the outward man of the named flank continuing to step

out at the full face. The word FORWARD, will be given when the rank has attained the direction intended, when the whole resume the full face and march straight forward.

Sec. 19.—The Diagonal March.

On the word RIGHT (or LEFT) HALF FACE, the men, if halted, make a half face, in the direction ordered, and, on the words QUICK MARCH being given, move on on the diagonal lines upon which they are individually placed, after having made the half face. On the words, HALT, FRONT, the original front is resumed.

If the rank is marching to the front, and it is required that they should take an oblique direction, the words, RIGHT (or LEFT) HALF TURN, will be given, when the men move as above directed, and when required to move to the original front without halting, the words FRONT, TURN, will be given, when each man turns his body to the front and moves forward without checking the pace.

In this march, the leading flank is the pivot for the time being; for instance, if the rank is to move by the right half turn, the right-hand man must pay particular attention to the length of pace, and must move perpendicularly to the line he took up when he made his half turn; the others being careful that their right-arms do not get beyond the centre of the men's backs who precede them in *echellon*, as this oblique movement is termed. If

they keep this position their right feet will just clear the left feet of the preceding files.

If this movement is to be performed to the left, the reverse of the foregoing instructions must be observed.

Sec. 20.—File Marching.

To the Right (or Left) Face. The men face as commanded, and cover each other exactly in file, so that the head of the men immediately in front may conceal the heads of all the others before him. On the words Quick March, the whole move off together, continuing at each step the full pace of thirty inches, in order that the original distance between each man may not be increased or diminished.

To do this correctly, the leader must march straight forward, and every man must follow, placing his foot on the ground in advance of the spot from whence the man in his front has just taken up his, so as to prevent opening out, or losing the compact formation. Looking down, or leaning back, must be avoided.

To the Right (or Left) Turn. On the word Turn, each man, without changing step or cadence, comes to the *right* (or *left*) on his own ground. Or Right (or Left) About Turn, when each, in his own person, performs this movement in the time prescribed for three distinct paces; then *marking time* till he receives the word Forward, he resumes the full pace of thirty inches, as before.

Right (or Left) Wheel. On the word Wheel, the leading man turns to the *Right* (or *Left*) and the remainder follow without checking the march.

Right (or Left) Countermarch. On the word Countermarch, the leading man wheels to the *right* (or *left*) *about*, followed by the remainder who lengthen their paces whilst in the act of countermarching, otherwise they would lose their distance.

When a Squad, or Company, drilling without arms, is to be dismissed, the words Stand at Ease, should be given, then Break, when the whole break off, and quit their ground without noise.

Chapter II.

ON THE MANUAL EXERCISE.

Time.—"Order, Arms"—"Shoulder, Arms."—"Secure, Arms."—"Port, Arms."—"Slope, Arms."—"Trail, Arms."—"Fix, Swords."—"Charge, Swords."—"Unfix, Swords."—"Change, Arms."—Method of Piling Arms.—Mode to be observed in Dismissing a Company.

Time.

The motions of the manual exercise should be smartly performed, leaving a pause between each motion equal to the time taken up in making one pace, when marching in slow time, that being the seventy-fifth part of a minute, except when fixing or unfixing swords, in which case a longer time is given.

In performing the motions care must be taken to preserve the squareness of the body, and to avoid raising or sinking the shoulders.

On *falling in* for drill or exercise, the men *order arms*, that is, the rifle is brought down to the right side, the butt being quietly placed on the ground even with the toe of the right foot, guard to the front; the right arm to be slightly bent, the hand to seize the rifle between the bands, the thumb

pressed against the thigh, and the fingers slanting towards the ground. The left hand at the left side in the position of *Attention.*

Shoulder Arms.

1st. Raise the rifle with a smart cant of the right hand, and seize the trigger guard between the forefinger and thumb at the full extent of the arm, the remaining fingers under the hammer, at the same time sieze the rifle also with the left hand in line with the elbow to steady it in the shoulder, arm close to the body.

2nd. Bring the left hand smartly to the left side.

Present Arms.

1st. Grasp the rifle with the left hand at the lower band, raising it a few inches by slightly bending the right arm, but without moving the barrel from the shoulder, and slip the thumb of the right hand under the hammer, bringing the fingers under the guard to the front, and slanting downwards; both arms close to the body; left hand square with the left elbow.

2nd. Raise the rifle with the right hand perpendicularly from the shoulder to the *poise*, bringing it in front of the centre of the body, lock to the front; at the same time place the left hand smartly on the stock with the fingers pointing upwards, the thumb close to the forefinger, the point in line with the mouth, the wrist on the trigger guard, the left elbow close to the butt, the right elbow and butt close to the body.

3rd. Bring the rifle down with a quick motion as low as the right hand will admit without constraint, guard to the front, and grasp it with the left hand, the little finger touching the projection above the lock plate, thumb between stock and barrel, at the same time draw back the right foot so that the hollow of it may touch the left heel; lightly holding the small of the butt with the right hand, fingers pointing rather downwards; the rifle in this position to be totally supported with the left hand, close in front of and opposite the centre of the body.

SHOULDER, ARMS.

1st. Bring the rifle to the right side, and seize it with the right hand, the thumb and forefinger round the guard at the full extent of the arm, remaining fingers under the hammer, bringing the left hand square with the left elbow and the right foot to its original position, both arms close to the body.

2nd. Bring the left hand smartly to the left side.

SECURE, ARMS.

1st. Grasp the rifle with the left hand as in the first motion of "*Present Arms.*"

2nd. Pass the rifle smartly to the left side, and cant the butt to the left rear, with the right hand to bring the rifle under the arm, quitting the right hand immediately to the right side; the hammer to be close up under the arm pit, the

barrel to be uppermost, slanting downwards, and inclining to the right front; the rifle to be firmly grasped with the left hand, which is to be rather below the hip; the left elbow a little to the rear; the lock not to be visible.

N.B.—In marching or standing at ease, the right hand grasps the rifle above the lower band, the sling or stock to rest on the left arm, and the left hand to lay hold of the right arm above the wrist.

Shoulder, Arms.

1st. Carry the rifle to the right side with the left hand, and seize it with the forefinger and thumb of the right hand round the guard (remaining fingers under the hammer) at the full extent of the arm without constraint, the left hand to steady it in the shoulder, arm close to the body.

2nd. Bring the left hand smartly to the left side.

Order, Arms.

1st. Grasp the rifle with the left hand, thumb and fingers round the piece, the little finger in line with the point of the right shoulder, but without removing the barrel therefrom, arm close in to the body.

2nd. Bring the rifle down in the left hand as low as the left arm will admit, keeping the arm and rifle close to the body, and with the right hand, which is to grasp the rifle between the bands, place the butt *quietly* on the ground even with the toe of

the right foot, bringing the left hand at the same instant smartly to the left side; the right arm to be slightly bent, the thumb pressed against the thigh, fingers slanting towards the ground.

SHOULDER, ARMS.

As before.

PORT, ARMS.

1st. Grasp the rifle with the left hand, as in the first motion of "*Secure Arms.*"

2nd. Bring the rifle in the left hand to a diagonal position across the body, lock to the front, and grasp the small of the butt at once with the right hand, thumb and fingers round the stock, the left wrist to be opposite the left breast, elbows close to the body, the muzzle slanting upwards, so that the barrel may cross opposite the point of the left shoulder.

SHOULDER, ARMS.

Bring the rifle to the right side, and drop the left hand smartly, as before.

SLOPE, ARMS.

1st. Grasp the rifle with the left hand as in the first motion of "*Secure Arms.*"

2nd. Bring the rifle to the left side, and seize it at once with the left hand, the two first joints of the fingers grasping the butt, the thumb alone to be on the heel of it, the muzzle to slant to the rear, and the guard pressed gently against the hollow of

the shoulder; the upper part of the left arm to be close into the side, the hand in a line with the elbow; the toe of the butt opposite the centre of the left thigh; the right hand holding the small, thumb and fingers round the stock, arm close in to the body.

3rd. Bring the right hand smartly to the right side.

STAND, AT EASE.

Bring the right hand smartly across the body and place it on the left hand, thumbs of both hands to be on the heel of the butt, that of the left nearest to the lock; at the same time move the left foot six inches to the front, with the toes pointing to the left front (feet separated) the left knee to be slightly bent, the greater part of the weight of the body to be brought on the right leg; no constraint.

ATTENTION.

Bring the left foot back in line with the right, and the right hand smartly to the right side.

SHOULDER, ARMS.

1st. Grasp the small of the butt with the right hand, fingers and thumb round the stock, arm close in to the body.

2nd. Bring the rifle to the right side, and drop the left hand smartly, as before.

ORDER, ARMS.

As before.

Stand, at Ease.

Push the muzzle of the rifle to the front with the right hand, arm close to the side; at the same time move the left foot six inches to the front, &c., as detailed before.

Trail, Arms, *(from the "Order.")*

Bring the rifle to a horizontal position at the right side, holding it with the right hand behind the lower band (thumb and fingers round the piece) at the full extent of the arm; the muzzle of the rear rank man's rifle to be just in front and clear of the wrist of his front rank man.

Trail, Arms, *(from the "Shoulder.")*

1st. Grasp the rifle with the left hand, little finger in line with the elbow, arm close in to the body.

2nd. Bring the rifle to a horizontal position at the right side, grasping it at once with the right hand behind the lower band, &c., as above.

Fix, Swords, *(from the "Order.")*

Place the rifle with the right hand smartly between the knees, guard to the front, and immediately seize the handle of the sword with the right hand (the left hand holding the scabbard) and draw it towards the muzzle, raising the point upwards when clear of the scabbard, and seize the rifle with the left hand at the "nose cap," then place the back part of the handle against the lock side of the

barrel, knuckles to the right, arms close to the body, and slide the spring on to the catch, and the ring on to the muzzle; when this is done, grasp the rifle with the right hand between the bands, bring the left hand smartly to the left side, and come to the position of "*Order Arms.*"

Shoulder, Arms.

As before.

Charge, Swords.

Make a right half-face by raising the toes and turning upon the heels, the right toes to point to the right, the left full to the front; at the same time grasp the rifle with the left hand at the lower band, and bring it down to nearly a horizontal position at the right side, with the muzzle inclining a little upwards, the right hand grasping the small of the butt, the wrist to rest against the hollow of the thigh below the hip, with the thumb pointing to the muzzle.

Shoulder, Arms.

As before.

Order, Arms.

As before.

Unfix, Swords.

Place the rifle with the right hand smartly between the knees, guard to the front, and seize it with the left hand at the "nose cap," as also the handle of the sword with the right hand, knuckles to the front, with the fingers pointing downwards;

then with the forefinger press the spring inwards, raise the sword upwards, and drop the point, with the edge to the front, towards the scabbard, raising the right elbow in doing so, at the same time move the left hand smartly, and seize the scabbard to guide the sword into it; this being done, grasp the rifle with the right hand, and come to the position of "*Order Arms.*"

STAND, AT EASE.

As before.

CHANGE, ARMS, *(when "Trailing" Arms.)*

Bring the rifle to a perpendicular position at the right side, and seize it with the left hand close above the sight and carry it round to the left side, bringing it to a horizontal position at the full extent of the arm.

When moving with "*trailed arms,*" at the word "*halt,*" arms are to be "*ordered.*" At the word "*March,*" arms are to be "*trailed,*" without any command to that effect.

ORDER, ARMS, *(from the "trail.")*

Bring the rifle at once to a perpendicular position at the right side, and place the butt quietly on the ground, and come to the position of "*order arms.*"

"*Trailed arms,*" for the ease of the soldier, may be used on the line of march, or in marching to and from the place of parade or exercise, or with guards marching to and from their posts, or when moving as light infantry.

"*Trailed Arms*" must never be used with fixed

swords, except in preparing to charge; nor in file marching, nor in any field movements where close marching is required.

If required to move a few paces backwards or forwards when at "*ordered arms*," the rifle is merely to be raised from the ground, keeping the barrel close to the shoulder; this position is called the "*short trail.*"

Method of Piling Arms.

(The company standing in close order, with ordered arms, and numbered from right to left.)

At the word Pile, the rear rank takes a pace of ten inches to the rear, and the front rank draw back their right feet in order to face to the right about; at the word Arms, the front rank face about, bringing their rifles with them to *ordered* arms; the front and rear rank men will then place the butts, locks inwards, against the inside of their outer feet as close to the heel as possible, after which the right file rear rank and the left file front rank incline their rifles towards each other, and cross ramrods; the right file front rank at once places his *left* hand round the muzzle of his left file, bearing it from him, and with his *right* hand locks ramrods by passing his by the left of the ramrods and to the right of the muzzles of the other rifles, the left file rear rank then lodges his rifle between the muzzles of the rifles of the front rank, sling uppermost. When there is an odd file, the front and rear rank man lodges his rifle against the pile nearest his *right hand.*

At the words STAND CLEAR, the ranks take a pace of ten inches backwards and face towards the pivot flank.

At the words STAND TO, the ranks, facing towards the pivot flank, face inwards and close on their arms by taking a pace of ten inches forward.

At the word UNPILE, seize the rifle with the right hand under the top band, the front rank at the same time drawing back their right feet in order to face to the right about; at the word ARMS, unlock the ramrods without hurry, by inclining the butts inwards, and come to *ordered arms*, the front rank then *fronts*, and the rear rank close on it by taking a pace of ten inches forward.

N.B.—It is necessary to be careful in piling and unpiling arms to prevent damage being done to the ramrods and sights.

MODE TO BE OBSERVED IN DISMISSING A SQUAD, OR COMPANY OFF PARADE.

SHOULDER, ARMS.

As before.

TO THE RIGHT, FACE.

As in Squad Drill.

LODGE, ARMS.

At the word *Arms*, the men *Port* arms, and in so doing the front rank takes a side pace to the left, and the rear rank a side pace to the right, and, after a pause, the company breaks off and quits the parade without noise.

CHAPTER III.

ON COMPANY DRILL.

Sizing a Company.—How the Men should know their places.—General Rules.—A Company in Line, and in Column —Open Order.—Formation of a Company in Column.—Marching to the Front and Rear.—Wheeling from the Halt, from Line into Column, and from Column into Line.—The Diagonal March.—Formation of Fours deep.

SIZING A COMPANY.

A COMPANY is *sized* from flanks to centre, the front and rear rank men being as nearly as possible the same height. When a company is first sized the following method is adopted:—Place the tallest man on the right, the second tallest on the left, leaving sufficient room between them for the company to form in single rank; then place the third tallest man on the inner side of the right-hand man, and so on alternately till they meet in the centre; after which, number off, and form two deep, by causing the left files of the right sub-division to take one pace to the rear, and one to the right, and the left files of the left sub-division to take one pace to the front and one pace to their right; the left hand man of the company, if a right file, must *also take a pace* to the front; lastly, cause the

whole to *close* and *dress* on the right file, the rear rank covering correctly, leaving the blank file, if there is one, the third from the left.

In numbering off, the *odd* numbers as 1, 3, 5, &c. are *right* files, and the *even* numbers, as 2, 4, 6, &c. are *left* files.

How the men should Know their places.

After the men of a company have once been sized in this manner, they should keep in mind their relative heights with regard to each other—that is, who should be on their right and left—and be able to fall in at once, in their proper places.

Formation and Telling-off of a Company.

The company should fall in in two ranks at close order with "*ordered arms*" (see *Manual Exercise*) the men lightly touching, and should be told off from right to left, odd numbers being right files and even numbers left files; it should then be divided into two sub-divisions, and four sections. When a company cannot be divided into sub-divisions of equal strength, in a *right* company the right sub-division should be the strongest; in a *left* company the left sub-division should be the strongest. When a sub-division is divided into sections of unequal strength, the *outward* section, on whichever flank of the company it may be placed, should be the strongest. Before a company, formed singly, is told off for drill, the instructor should give the caution, Tell off as a Right (or Left) Company.

General Rules.

The following General Rules should be observed, in the movements of a company, whether alone, or with the rest of the Corps.

1st. At all times, when a company, sub-division, or section wheels forward, the rear rank man of the pivot file uncovers by taking a pace to his rear, and a pace of twenty-one inches to his side, so as to cover the rear rank man of the file next to him.

2nd. When a company, sub-division, or section wheels back, whether it is faced about to wheel, or not, the rear rank man of the pivot file remains in his place, and should not uncover.

3rd. The front rank man of the pivot file is usually called "the pivot man."

4th. When the captain of a company changes his flank the coverer, if not required to take a point, changes with him; the lieutenant also makes a corresponding change.

5th. When the leader of a company, sub-division, or section, changes his flank on the march, he gives the words, *By the right*, or *By the left*, as he falls in in his new place; if he changes during a wheel the above words should immediately follow the word, *Forward*.

6th. Commanders of Companies, previously to giving the word of command, should call out the number of their companies thus, *No.* 1—*Halt*. When in motion, executive words must be given as the men are commencing the pace, which will bring them to the spot on which the command has to be

executed. The cautionary part of the word must, therefore, be commenced accordingly.

N.B. In order to distinguish the words of command given by the Instructor of the drill or the Commander of the corps, from those given by the Commander of the company, or its sub-divisions, or sections, the commands of the former are in CAPITAL letters, those of the latter in *italics*.

A COMPANY IN LINE, AND IN COLUMN.

Sec. 1.—Formation of a Company in Line.

Caution.—AS A COMPANY IN LINE.

On the above caution, the Captain places himself on the right of the front rank, covered by a serjeant, called the "covering serjeant," who should be on the right of the rear rank. The other officers and, serjeants place themselves in a third or supernumerary rank, three paces from the rear rank; the first Lieutenant in rear of the second file from the left, the second subaltern in rear of the centre of the company, the third supernumerary in rear of the left sub-division, the fourth in rear of the right, the fifth in rear of the left, and so on. If there are three subalterns, the senior should be as already placed, the next in rear of the third, and the junior in rear of the second section; all dressing by the right. Supernumerary serjeants should then, according to seniority, be in the rear of the different sections with the subalterns and aligned with them.

The principal duty of the supernumerary rank is

to keep the others closed up, to correct mistakes, and to take a general supervision of that part of the of the company allotted to them.

In the absence of any of the officers, their places should be taken by the next in rank, whether officers or serjeants, who perform all the duties of the superior position, except that in taking open order, no serjeants should ever move out in front of the line, but should retain the posts they held in close order. When required, corporals from the ranks should supply the places of serjeants.

Rear Rank Take Open Order.

On the word Order, the officers "recover swords" and move out; (the junior, if there are three subalterns, but not otherwise, going by the right flank of the company,) and place themselves—the captain one pace in front of the second file from the right; the first and second subalterns, (passing round the left flank of the company), one pace in front of those files in rear of which they stood when the order was given.

The right and left-hand men of the rear rank step back two paces and face to the right.

The covering serjeant takes a lengthened side step to the left, thus occupying the space vacated by the right-hand man of the rear rank.

March.—On the word March, the officers take two paces to the front, look to their right and dress; the covering serjeant takes one pace to his right with his right foot, and one pace to his front with his left foot, thus filling up the place vacated by *the Captain.*

The rear and supernumerary ranks step back two paces, and the flank men of the rear rank face to the front.

Rear Rank Dress.—On the word *Dress*, the rear and supernumerary ranks look to their right and dress.—On the words *Eyes-Front*, they turn their eyes to the front.

Steady.—On the word *Steady*, the Officers "port swords," and look to the front.

When a company is formed singly, the captain dresses the officers and gives the words *Steady*; the serjeant on the right of the supernumerary rank dresses the rear and supernumerary ranks, and gives the words *Eyes-Front*, as the dressing of each is completed.

Rear Rank Take Close Order,—On the word Order, the officers "recover swords," and face to the right.

March,—On the word March, the officers (passing by the right and left flanks of the company, as in take open order) return to their places, and "carry swords" as they take post.

The covering serjeant takes two paces to his rear and one to his left, to make room for the officers (if any) to pass; he then moves up to his place on the right of the rear rank.

The rear and supernumerary ranks take two paces to the front.

When a company is formed in line, if the captain is required to change his flank he passes by the rear, except when it is preparatory to closing to the right or left. The covering serjeants and supernumeraries always pass by the rear.

Sec. 2. Formation of a Company in Column.

Caution.—As a Company in column Right (or Left) in front.

On the caution, the captain places himself on the pivot flank of the front rank to lead his company, the first lieutenant places himself one pace in rear of the second file from the reverse flank, and the covering serjeant one pace in rear of the second file from the pivot flank. The places of the remaining supernumeraries will be the same as in line, but at one pace distance from the rear rank.

When the column is right in front, that is, when the company that stands on the right, when in line, is in front, the left will be the pivot flank of each company; when the column is left in front, the right will be the pivot flank of each company.

When a company is in column, either halted or on the march, and the captain is required to change his flank, he always passes by the rear, except during some wheels from line to column, and column to line. The covering serjeant and the supernumeraries also cross by the rear.

Sec. 3.—Marching to the front and Rear.

The Instructor, having stated the supposed order of the Batallion, proceeds as follows.

The Line (or Column) will advance.

On the word Advance, the Captain carefully selects points to march upon.

QUICK (OR DOUBLE) MARCH. — (As described in Sec. 7 and 14, Chap. I., Part II.) HALT.

When the Company is to retire, the caution, THE LINE (OR COLUMN) WILL RETIRE, will be given. The men will then be faced about, and the blank files will step up in line with the proper rear rank. The Captain, if the company is in column, also steps up in line with the proper rear rank and selects points to march on; but if the company is in line, he remains on the flank of the proper front rank.

WHEELING FROM THE HALT.

Sec. 4.—A company wheeling from the Halt, from Column into Line.

A company wheels from column into line, and line into column, on the principles laid down in Sec. 16 and 17, Chap. I., Part II. The Officers and Serjeants move as follows:—

Caution.—AS A COMPANY IN COLUMN RIGHT IN FRONT.

LEFT WHEEL INTO LINE.—On the word LINE, the Captain places himself one pace in front of the second file from the left; the covering serjeant runs to the front, and marks the spot on which the right of the company will rest, when the wheel is completed; he faces in the direction of the new front, and, looking to his left, aligns himself with the pivot man.

QUICK-MARCH.—On the word MARCH, the company steps off and wheels as described in Sec. 16,

Chap. I., Part II., the Captain turning towards his men and moving back round the pivot man to be ready to dress his company from the left; the first Lieutenant moving across to his place in line, and the supernumerary rank gaining its distance from the rear rank, during the wheel.

Company—Halt-Dress.—The Captain gives his word *Halt*, when the wheeling flank of his company is two paces in rear of the covering serjeant, and immediately follows it by the word *Dress*, on which he dresses his men from the pivot flank.

Eyes-Front.—Having completed the dressing, the Captain gives the words *Eyes-Front*, and falls in on the right of his company; the covering serjeant falls back to his place on the right of the rear rank; the remainder turn their eyes to the front.

A company in column, left in front, should be taught to wheel into line in a similar manner, on the commands Right Wheel into Line, &c.

Sec. 5.—A Company Wheeling, from the Halt, from Line into Column.

Caution.—As a Company in Line.

Open Column right in Front.—On the word Front, the Captain moves out and places himself one pace in front of the centre of his company, facing to the front; the covering serjeant runs to the rear, and marks the spot on which the right of the company will rest, when the wheel is completed; facing in the direction that the column will face.

The pivot man, that is, the left hand man of the front rank of the company, faces to the right.

RIGHT ABOUT-FACE.—On the word FACE, the company faces about; the pivot man and covering serjeant remaining steady.

RIGHT WHEEL, QUICK-MARCH.—On the word MARCH, the company steps off and wheels as already directed; the Captain moving to the pivot flank, and the first Lieutenant moving across to his place in column during the wheel.

Company, Halt-Front-Dress.—The captain having given the words *Halt, Front, Dress,* falls in at once on the left flank of his company looking to his front; the covering serjeant at the same time moves to his proper place in column; and the supernumerary rank steps up to its proper distance from the rear rank. Having completed their dressing, the men turn their eyes to the front without further word of command.

A company in line should also be taught to wheel into an open column left in front in like manner, in which case the right hand man faces to his left on the caution, and the company, having been faced about, wheel to the left.

Sec. 6.—WHEELING BACKWARD BY SUB-DIVISIONS OR SECTIONS, FROM LINE.

BY SUBDIVISIONS (OR SECTIONS) ON THE LEFT BACKWARD WHEEL.—On the word WHEEL, the Captain places himself one pace in front of the

centre of the right subdivision (or section); the covering serjeant moving back, and marking the spot on which the right of the leading sub-division or section will rest; the left hand men of the front rank of each sub-division (or section) facing to the right.

QUICK-MARCH.—On the word MARCH, the sub-divisions (or sections) wheel backwards as described in Sec. 17, Chap. I, Part II, the Captain inclining to the left.

Halt-Dress.—The Captain gives the words *Halt-Dress*, and takes his place on the left of the leading sub-division (or section), the covering serjeant, passing by the rear, takes his place in column, one pace in rear of the second file from the pivot flank of the same sub-division; the senior subaltern takes his post on the pivot flank of the rear-subdivision; the second subaltern in rear of the second file from the reverse flank of the rear sub-division.

In like manner sub-divisions or sections will *wheel backwards on the right.*

Sec. 7.—AN OPEN COLUMN OF SUB-DIVISIONS OR SECTIONS, WHEELING INTO LINE.

LEFT WHEEL INTO LINE.—On the word LINE, the Captain falls back and places himself one pace in front of the second file from the left of the rear sub-division (or section) in column. The pivot men face to the left, their rear rank men uncover, the

leader of the rear sub-division (or section) falls back into the supernumerary rank, and the covering serjeant moves out and marks the spot on which the right of the company will rest, and raises his left arm.

QUICK-MARCH.—On the word MARCH, the sub-divisions or sections will step off and wheel into line as before described, the Captain turning towards his men and moving back round the pivot man to be ready to dress his company from the left. The supernumeraries move to their places during the wheel.

Halt-Dress.—On the words *Halt-Dress,* the men halt, and the Captain dresses them from the left.

Eyes Front.—On the words *Eyes Front,* the whole turn their eyes to the front, the Captain and covering Serjeant take their places in the line,the former passing by the rear.

N.B. In like manner a company in column of sub-divisions or sections *left in front,* wheel into line on the commands, RIGHT WHEEL INTO LINE, &c.

Sec. 8.—The Diagonal March.

In *column,* when a company inclines towards the pivot flank, the Captain will lead; when towards the reverse flank, the senior supernumerary will move up and lead, unless the Captain is ordered to change his flank.

Sec. 9.—Formation of Fours Deep.

Form Fours.—On the word Fours, the rear rank steps back one short pace of twelve inches.

On the word Deep, the left files double behind the right files, by taking a pace to the rear with the left feet, and pace to the right with the right feet.

On the word Front, the left files move up in line with the right files, by taking a pace to the left with their left feet, and a pace to the front with their right feet; the whole of the rear rank men then close up to their proper distances from the front rank by taking a short pace to the front with their left feet.

Form Fours.—As already described.

On the word About, the whole face to the right about, and the left files double in the proper rear of the right files, by taking a pace to the front with the right feet, and a pace to the left with their left feet.

On the word Front, the whole face to the right about, and re-form two deep, as already described.

Form Fours.—As already described.

On the word Right, the whole face to the right, and the left files form on the right of the right files, by taking one pace to the right with the right feet, and one pace to the front with their left feet.

On the word Front, the whole face to the left, and re-form two deep, as already described.

Form Fours.—As already described.

On the word Left, the whole face to the left, *and the left files* form on the left of the right files

by taking one pace to the left with their left feet, and one pace to the rear with their right feet.

On the word FRONT, the whole face to the right, and re-form two deep, as already described.

To form FOURS to the right or left on the march, on the word FOURS, the rear rank mark time one pace ; on the word RIGHT, or LEFT, the whole turn to the named flank; the right files mark time two paces, while the left files move to their places as when halted; the whole then move on in the new direction. On the words FRONT-TURN, the whole turn to the front; the right files mark time two paces for the left files to resume their places, and the rear rank to regain its distance, the whole then march steadily to the front. In retiring, *fours* may be formed in like manner to the right or left, in which case the proper front rank mark time one pace on the word FOURS.

A party moving to a flank in fours may be ordered to *Form Two deep*, on which the left files fall back or step up to their places in file, and the rear rank close on the front rank ; and at the words *Re-form Four deep*, the rear rank incline from the front rank, and the left files resume their places in fours.

In forming *fours*, the men move as already explained, and the supernumerary rank on the word FOURS, step back one pace. Both in *file* marching and the flank march by fours, the Captain leads the company, placing himself next to the front rank

man of the leading file or four; the covering Serjeant places himself at the head of the front man; the Lieutenant on the reverse flank of the second file or four from the rear; the other supernumeraries simply face with the company, and retain positions.

When a company in close column takes ground to a flank by *fours*, the leader places himself in front of the front rank man of the leading four, the covering serjeant next to him in front of the second rank.

Chapter IV.

LIGHT INFANTRY MOVEMENTS.

Extending, from the Halt, and on the March.—Closing, on the Halt, and on the March.—Advancing and Retiring in Skirmishing order. —Inclining to a Flank.—Changing Front, from the Halt, and on the March.—Skirmishers Wheeling.—Firing in Skirmishing order. —Relieving Skirmishers.—Forming Solid and Rallying Squares.— Advanced Guards.

When a Regiment is employed as Light Infantry, as Rifle Volunteers will be, it is usually divided into three parts, Skirmishers, Supports, and Reserve; but it may frequently be deemed advisable to cover the movements of a line with skirmishers and supports, or skirmishers only.

The *supports* should always be composed of numbers equal to the line of *skirmishers;* thus, each company that is extended should have a company to support it. The *reserve* should be at least one third part of the whole body. If a single company is detached to skirmish at a distance from the main body, no more than one half of the men should ever be sent forward to skirmish at a time; the other half must remain formed in support.

The *movements* of the *skirmishers* must depend in a great measure on the position and movements of the enemy. The *duty* of *supports* is to assist and

support the skirmishers in every way; the movements of the former must therefore correspond with those of the latter. Each support should be, as nearly as possible, in rear of the centre of its own skirmishers. The *reserve* is the *point* on which both supports and skirmishers may rally; and as it should send relief to them when necessary, it should be placed as nearly as possible in rear of the centre of the formation.

The *distance* of supports from the skirmishers, and reserves from supports, must depend on circumstances and the nature of the ground. The supports should always be in the most convenient position to assist the skirmishers, without being unnecessarily exposed to fire. For instance, when skirmishers have ascended a bank or hill, and are halted on the summit, it is evident that the supports may approach close to them, without being exposed to fire; but, on a plain, they must necessarily be kept at a greater distance; the same remark applies to the reserve. As a general rule, on a plain the distance between skirmishers and supports should be about 200 yards; between supports and reserve, about 300 yards; between the reserve and main body, 500 yards.

When *under fire*, skirmishers, whether halted or in motion, must take advantage of all *cover*, and, although they are not required to preserve their distances and dressing while so doing, they must, when advancing or retiring, take care that they never get in front of each other, and that they

never retain their places of cover so long as to interfere either with their own fire or with that of their comrades. Officers commanding supports must, with due regard to the assistance they should afford to the skirmishers, take advantage of all inequalities of ground and other objects affording cover to protect their men, and should make them lie down when cover can be obtained by so doing; they should examine the ground well, and select positions that will protect them from cavalry, in case of attack, without preventing the skirmishers from forming upon them. The officer commanding the reserve should also keep his men under cover when practicable; but, as the reserve is not immediately under fire, his attention should principally be directed to the selection of positions, favourable to the relief and assistance of the skirmishers and supports. When in the presence of cavalry, the reserve should be kept in column; but under the fire of artillery, it should be deployed into line.

Light Infantry *movements* are usually performed in *quick* time, except extensions or closings on the march, the formation of company or rallying squares, and changes of front from the halt; they are performed in *double* time. When more than usual rapidity is required in other movements, the men may be directed to *double* by word of command or bugle sound.

All lines of skirmishers move by their centre, except when inclining to a flank, in which case, they move by the flank to which they are inclining.

The skirmishers and supports move with "*trailed*" arms, except in close column of sections, or in files, when the move with "*shouldered*" arms; reserves move with "*shouldered*" arms.

When a company is extended, the Captain should generally be at a convenient distance in rear of the centre; the supernumeraries should be placed at equal distances along the rear of the line of skirmishers, the first Lieutenant being always near the outer flank of a flank company. When a company is in *support*, the Captain should be in its *proper* front, whether it is advancing or retiring, he will thus lead his company when it advances, and follow it when it retires. The supernumeraries of a support should be in the rear. The Officers of a *reserve* should always be placed as in column, right in front. A non-commissioned Officer, or more if necessary, may frequently be sent out with advantage from a support to keep up the connexion with its skirmishers. Non-commissioned Officers may also be sent out from the *reserve* to keep up the connexion between it and each support; these are called *connecting links*.

Light Infantry *movements* should in general be regulated by *word* of command. Commands should be repeated by the Captain and every supernumerary belonging to the line of skirmishers. The connecting links may be employed, when necessary, to pass words of command, or convey intelligence backwards and forwards between the reserves and supports, and between the supports and skirmishers.

When on account of the distance, or from noise or wind, the voice cannot be distinctly heard, the connecting links should run up and deliver their orders to the Officers for whom they are intended, and then resume their places. *Calls* on the Bugle may occasionally be necessary as substitutes for the voice, but as they are liable to be misunderstood, and as they reveal intended movements to the enemy, who will soon become acquainted with them, they should seldom be used, unless for purposes of drill. Bugle sounds must therefore be as few and simple as possible, and none but the following, according to the Horse Guards circular, should ever be used in light drill.

One G sounded on the Bugle denotes the *right* of the line; two G's the *centre*; and three G's the *left*, as under:

One G. Two G's. Three G's

Right. Centre. Left.

The G's preceding any sound denote the part of the line to which it applies. For instance: two G's before the EXTEND, signifies, to extend from the centre. One G, followed by the CLOSE, to close to the Right. One G, followed by the INCLINE, to incline to the Right. Three G's, followed by the WHEEL, to wheel to the Left.

Every Regiment should have a well marked and simple regimental call. The ADVANCE or the RETIRE

On the word Extend, or on the last sound of the bugle, the Captain places himself in rear of the centre of the Company, the senior supernumerary in rear of the right, and the second senior in rear of the left.

The file on the named flank, or the centre or named file, kneels down, the remainder "shoulder arms," face outwards, and extend in quick time.

The front rank men move direct to the flank, covering correctly on the march, the rear rank men cast their eyes over the inward shoulder, and tap their respective front rank men as a signal to halt, front, and kneel, when they have gained their proper distances.

The men should be taught to extend from any file of a close column of sections, without previously re-forming company; the named file to kneel, and the remainder to face outwards and extend as already descrided.

From the Right, (Left, Centre, or No.—File,)—Extend. *(On the March.)* On the word Extend, or on the last sound of the Bugle, the file on the named flank, or the centre or named file, will continue to move straight forward in quick time, the remainder make a half turn to the flank to which they are ordered to extend, and move off in double time. As soon as each file has extended to its proper distance, it turns to its front and resumes the quick time; the rear rank men covering their front rank men, and the whole keeping in line with the directing file.

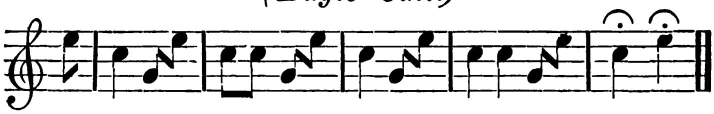
Men in extended order may be directed to increase the distance between their files any given number of paces, from either flank, the centre, or any named file. The command will be given thus, To Eight paces from the Right,—Extend; if no number of paces is specified, or if the Bugle sound the Extend, the skirmishers will open out one half more than their original extension; thus, if they are at six paces distance, they will open to nine.

When a company, extending on the march, is halted before all the files are extended, the remainder make a half turn outwards into file, break into quick time, "shoulder arms," and complete their extension as from the halt.

Sec. 2.—CLOSING.

On the Right (Left, Centre, on No. — File,) Close. *(On the Halt.)*

(Bugle Call.)



On the word Close, or on the last sound of the Bugle, the file on the named flank, or the centre, or named file, will rise, order arms, and stand at ease; the remainder will rise, face towards it, and close at quick time, halting, fronting, ordering arms, and standing at ease in succession as they arrive at their places; the officers remain in the rear unless directed to take post.

The file on which the skirmishers close, may be

faced in any direction; the remainder forming upon it, facing in the same direction.

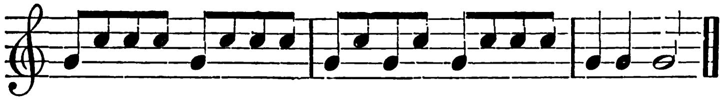
On the Right, (Left, Centre, or No.—File) Close. *(On the March.)* On the word Close, or on the last sound of the Bugle, the file on the named flank or centre, or the named file, moves steadily on in quick time; the remainder make a half turn towards it and close in double time, turning to the front and resuming the quick time as they arrive at their places.

When a company, closing on the march, is halted before all the files are closed, the remainder make a half turn inwards into file, break into quick time, and complete the formation as from the halt.

Sec. 3.—Advancing in Skirmishing Order.

Company—Advance.

(Bugle Call.)



On the word Advance, or on the last sound of the Bugle, the men rise and step off in quick time with trailed arms, keeping their distance from the centre.

Sec. 4.—Retiring in Skirmishing Order.

Company—Retire.

(Bugle Call.)

On the word Retire, or on the last sound of the Bugle, the men rise, face to the right about, and step off in quick time, rear rank in front, keeping their distance from the centre.

Men in extended order invariably face or turn to the right about, whether they are advancing, retiring, firing, or not firing.

Sec. 5.—Inclining to a Flank.

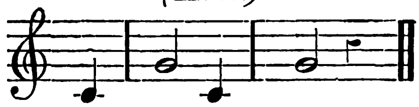
To the Right or Left Incline.

(*Bugle Call*) one G. (or three G's.)

On the word Incline, or on the last sound of the Bugle, the skirmishers make a half turn to the flank to which they are ordered to incline, and move in a diagonal direction, until they are ordered to resume their original direction to the front or rear, by the word or sound Advance or Retire. If the skirmishers have made a half turn, and are again ordered to incline in the same direction, or the Bugle sounds the Incline a second time, they complete the turn by making a second half turn and take ground to the flank in file.

If the Halt sounds when men are inclining, they halt, front, and kneel.

(Halt.)



N.B.—This sound annuls all previous sounds except the FIRE.

Sec. 6.—SKIRMISHERS CHANGING FRONT OR DIRECTION FROM THE HALT.

A line of skirmishers halted, can change front on any two named files that may be placed as a base for the rest to form upon.

A change of front in this manner may be made at any angle, but it is not likely to be required to a greater extent than the sixteenth, or at most the eighth of a circle.

CHANGE FRONT TO THE RIGHT (OR LEFT) ON THE TWO CENTRE, (OR ON NO. — AND NO. —) FILES.—*(From the Halt.)*

On the Caution, the two named files rise, and the Captain of the Company dresses them in the direction required; as soon as they are placed they again kneel.

DOUBLE MARCH.—On the word MARCH, the whole rise, and if all the files are to be thrown forward on a flank, they make a half face inwards, and move across by the shortest way to their places in the new line, dressing on the two base files, as they successively halt, and then kneeling.

If all the files are to be thrown back on either flank, they make a three-quarters face in the direction of the base files, then move across and

halt, front, and kneel successively as they arrive at their places in the new line.

If the change is on two central files, part of the company will be thrown forward and the rest back, as above described.

Recruits should first be taught this movement in quick time, and by seperate words of command; thus, after placing the base files, Rise; Left Sub-division Right Half Face; Right Sub-division Left About Three Quarters-Face, The Whole, Quick March.

Skirmishers Right (or Left) Wheel, (*On the March.*) (*Bugle Call*) one G (or three G's)

A line of skirmishers on the march may change their direction gradually, on the same principles, as a company wheels on a moveable pivot. On the word *Wheel*, or on the last sound of the Bugle, the pivot file halts, and the remainder circle round it, the front-rank men looking outwards for the dressing, and the rear-rank men keeping the distances from the pivot flank.

Forward.—On the word Forward, the whole line advances by the centre.

Sec. 7.—Firing in Skirmishing Order.

The men of a file should always work together. Both men should never be unloaded at the same time; they should always load when practicable

under cover; before moving to the front, when advancing, and after falling back, when retiring.

Commence Firing. (*Firing on the Halt.*)
(*Bugle Call.*)

On the words Commence Firing, or on the last sound of the Bugle, the front-rank men make ready, fire, and load; the rear-rank men when their front-rank men are in the act of capping, make ready, fire, and then load.

A line of skirmishers may be ordered to lie down, or single riflemen may lie down for the sake of cover. When firing in this position both elbows must rest on the ground to support the body and rifle; the men load on their knees.

Commence Firing, (*Firing when Advancing.*)

On the words Commence Firing, or on the last sound of the Bugle, the whole of the skirmishers make a momentary halt, the front rank man of each file fires (kneeling, if preferred), and takes a side pace to his left; the rear rank man then passes on, and the front rank man follows close behind him, loading on the march; when in the act of capping he gives the word "*Ready*" in an under tone of voice, on which the proper rear rank man fires, and both men proceed as above described.

When men find a difficulty in loading on the march, they may halt and load, and then double up to their file leaders.

When cover presents itself, the men must be taught to take advantage of it, by running forward from place to place as soon as they are loaded; when any large object affording considerable cover comes in the way, several files may run up behind it, fire, load, and then move on and regain their distances and places in the general line.

COMMENCE FIRING, *(Firing when Retiring.)*

On the words COMMENCE FIRING, or on the last sound of the Bugle, both ranks halt and front, the front rank man of each file fires, faces to the right about, and retires in quick time, passing by the left of his rear rank man (who follows close behind him), and loading as he retires; when his loading is completed, both ranks halt and front, the rear rank man fires and proceeds in the manner described for the front rank man.

On rough ground, files run back from one place of cover to another, taking care before they leave one station, to select another to fall back upon. One man of each file should fire previous to moving, and re-load when he is again under cover. As the principal object is to keep the enemy in check, skirmishers, when retiring, should hold each station as long as possible, without risk of being cut off by the enemy, or of being shot by their comrades.

When a line of skirmishers halted, is ordered to advance or retire firing, the front rank men first fire, the whole then rise, and proceed as already described.

Firing while inclining to a Flank, or taking Ground to a Flank in Files.

When skirmishers are ordered to fire, or the Bugle sounds the fire, while they are inclining to the right or left, or taking ground to a flank in files, the front rank men halt, take steady aim and fire, the rear rank men moving on; having fired, the front rank men double up to the proper rear of their rear rank men, and then load on the march or load at the halt, and then double up. When their loading is completed, the rear rank men proceed in like manner.

When skirmishers, either halted or on the march, are directed to

CEASE FIRING.

(Bugle Call.)

they complete their loading, and the rear rank men resume their places in the proper rear of their front rank men, if not there already.

Whenever skirmishers are directed to *halt*, by word of command or bugle sound, they should halt and kneel, facing to their proper front, and if *firing*, they should continue firing.

Sec. 8.—RELIEVING SKIRMISHERS.

The most convenient method of effecting the relief, is to order the supports to extend and relieve their own skirmishers.

When *retiring*, the successive relief of the skirmishers by supports, is the most effectual means of keeping an enemy in check: the officer commanding

a support should, therefore, be constantly on the look-out for good positions, in which he may extend they should run through them to the rear, until his men with advantage, such as a bank, a ditch, a wall, or such like cover. After relieving, the new skirmishers must hold their position until ordered to continue the retreat.

To relieve skirmishers that are *halted*, the supports should extend in the rear, out of immediate reach of the enemy's fire, and then run up to the old line. The old skirmishers, on being relieved, should run straight to their rear, and when out of immediate reach of the enemy's fire, close on the centres of companies and form supports.

Should an immediate *advance* be intended, the old skirmishers, on being relieved, should remain lying down till the new skirmishers have gained sufficient distance to their front; they should then rise close on the centres of companies, and form supports.

To relieve skirmishers that are *advancing*, the supports should extend on the march, and then double up to the old skirmishers, changing into quick time as they pass through them, on which the old line should lie down, and wait till the new skirmishers are sufficiently advanced to protect them from immediate fire, when they should rise, and each company close to the centre, forming supports.

To relieve skirmishers that are *retiring*, the supports should halt, front, and extend at a considerable distance in the rear, each man if possible getting under cover. When the old skirmishers arrive within about 20 or 30 paces of the new,

they are out of the immediate reach of the enemy's fire, and then close on the centres of companies, and form supports.

When skirmishers are relieved, and they find that fresh supports have been sent out from the reserve, they should form in rear of them, and afterwards proceed to join the reserve, in columns of sections at quick time. If necessary, their supply of ammunition can then be replenished.

Fresh companies may be sent out at any time from the reserve to relieve the supports.

Sec. 9.—The Alarm, or Look out for Cavalry.

When skirmishers are unexpectedly attacked by Cavalry the bugle should sound.

The Alarm, or Look out for Cavalry.

(Bugle Call.)

or the words Look out for Cavalry should be given, on which the skirmishers should at once form close column of sections, and prepare for cavalry, unless in disorder or scattered, in which case they should form rallying squares, which may be signified for parade purposes by

The Double Time.

(Bugle Call.)

being sounded after the alarm. The supports should form close columns of sections and advance by command of their Captains; the reserve should also advance, the companies forming four deep on the march, and closing on their centre by word of the commanding officer. As soon as the cavalry approach the skirmishers' squares, which will be signified when at drill by the sound COMMENCE FIRING, the supports should be halted and ordered to prepare for cavalry, and together with the skirmishers should commence firing; the reserve should also be ordered to form square on the leading company; which should be halted by its captain; the centre companies should be wheeled outwards by subdivisions, the rear company should close up, and should then be halted and faced to the right about. If only two companies are in reserve, they should form four deep as above directed, and when near the supports, should halt at quarter distance, the rear company being faced about, and the flanks of both dressed back till they meet, forming an oval.

The squares of skirmishers and supports will rarely be found in straight lines or directly one behind another; but, when such is the case, the Captains, if time will permit, should endeavour to move them into echellon, in order that they may protect each other mutually by their fire.

In the event of the squares being formed exactly in line or one behind another, the observance of the following general rule will prevent officers from acting at cross purposes. The skirmishers' squares,

which will have but very little time to move, should look only to each other, and if in line the centre and right squares should retire into echellon, the left square standing fast. The supports, which will have more time, will move not only into echellon with each other, but also with the skirmishers' squares; as regards each other, the centre and left supports should advance into echellon, either by continuing to move on after the right support has halted, or by moving to the front at the double; as regards the skirmishers' squares the right and left supports should take ground outwards, the centre support to the left; the reserve should incline to the right. The same rule will equally apply when only two companies are skirmishing, by omitting the directions to the centre skirmishers and support, and causing the reserve to move straight to its front.

If a battalion is required to extend again from this formation, the skirmishers should extend from the files on which they closed. The supports should re-form companies and resume their former places, and the reserve should fall back to its original position, unless the skirmishers are about to advance, in which case, the supports and reserve may lie down till at sufficient distance from the front.

SQUARES.

Sec. 10.—FORMING CLOSE COLUMN OF SECTIONS AND COMPANY SQUARE.

FORM CLOSE COLUMN OF SECTIONS.—On the word SECTIONS, the men *Shoulder Arms*, if they

have not already done so, and the right section faces to the left, and disengages to the front by the leading file closing two paces to the right, the front rank men inclining rather back, the third and fourth sections face to the right and disengage to the rear, in the same manner.

QUICK MARCH. — On the word MARCH, the second section *fixes swords*, and the other sections step off and form close column on the second section, halting, fronting, and fixing swords, without word of command, as they arrive in column: the distance between the sections should be one pace; the Captain placing himself on the left of the front rank of the leading section, covered by his covering serjeant, the supernumeraries on the reverse flank of their respective sections.

PREPARE FOR CAVALRY.—On these words being given, the officers and non-commissioned officers move into the centre of the column; the men then face outwards, so as to show a front of equal strength in every direction.

READY.—On the word READY, if the square is two or three deep, the front rank will kneel, but if four deep, the two front ranks will kneel, on the right knee, and place the butts of their rifles on the ground against the inside of their right knees, locks turned uppermost, the muzzle standing upwards, so that the point of the sword will be about the height of a horse's nose; the left hand to have a firm grasp of the rifle immediately above the third band, the right hand holding the small of the butt, the left

arm to rest upon the thigh about six inches in rear of the left knee. The third and fourth ranks to *make ready* to fire, the fourth rank taking a short pace nearer to the third rank. The muzzles of the rifles to be inclined upwards.

In *Loading*, the kneeling ranks spring to *attention* at the *half-face*, and bring the rifle to a horizontal position at the right side, seizing it at the same instant with the right hand close in front of the left, and from thence come to the position of *prepare to load*, as standing, and go on with the loading in quick time.

RE-FORM COLUMN.—On the word COLUMN, the men face to their proper front in column, and *touch* into the pivot flanks; the Captain and supernumeraries return to their places on the flanks.

RE-FORM COMPANY.—On the word COMPANY, the leading section faces to the right; the third and fourth to the left.

QUICK, MARCH.—On the word MARCH, they move out, the right section turning to the rear when clear of the second section, halts, fronts, and dresses upon it. The third and fourth sections turn to the front in succession, when clear, and dress up into line with the second section without word of command.

If the men count the number of paces that take them into column, by taking the same number when re-forming company, they will be able to turn to the front and rear together.

Sec. 11.—Forming Rallying Squares.

The instructor of the drill having caused the Company to disperse to a certain distance, gives the words Form Rallying Square, at the same time placing an officer as a rallying point, who holds up his sword and faces the supposed enemy; the men hasten to the person so posted, *fixing swords* and *ordering arms* as they reach him. The two first who join him form on his right and left, facing outwards. The three next place themselves in front of those posted, and three others in rear, facing to the rear, thus forming a square. The instructor should then cause the next four men to take posts at the several angles; and others, as they come up, complete the different faces between the angles.

A square thus composed of twenty-four men (besides the rallying point,) and formed two deep, may be augmented to a square three deep, by four more men taking posts at the angles, and others coming up to complete the faces as before; the square will then consist of forty-eight men, and may be augmented in the same manner to a square four deep, by the angles being occupied by four more men, and the faces filled up as before, when the square will then be composed of eighty men.

The Square will Advance (Reform, or move to the Right or Left). Inwards, Face, Quick March. When the square is required to march, the instructor previously to putting it in motion, will cause the leading face to be *dressed*, in

order that it may move with the necessary regularity. After the caution he will give the words INWARDS FACE, on which the square will face in the named direction, and step off at the words QUICK MARCH.

HALT. PREPARE FOR CAVALRY—READY. Upon the word HALT, the square halts and faces outwards. When it is to PREPARE FOR CAVALRY; upon the word READY, the front rank only (if the square is two or three deep) will kneel: if four deep, the two front ranks will kneel. If required to fire, the standing ranks will fire by files and the kneeling ranks in volleys by command of the commanding officer.

RE-FORM COMPANY (SUB-DIVISION, or SECTION.) When the square is to be reduced, the covering serjeant will mark the pivot flank of the company, facing the supposed enemy, and the men form company upon him.

In this manner dispersed parties may be formed to resist an attack of cavalry in an open country either in one or more squares, according as they may be more or less dispersed; each square consisting of any number of men. Every man should run to the nearest rallying point.

Sec.—12.—ADVANCED GUARDS.

Advanced Guards are formed in front of a column, to gain intelligence of the enemy, and to give timely notice of his vicinity or approach, in

order that the main body may have time to prepare either for making or repelling an attack.

No specific rules can be laid down for the conduct of an advanced guard, where every instance of falling in with an enemy must vary; the officer in command of the guard must depend on his own intelligence for the proper execution of this most important duty, and allowing nothing to escape his personal observation.

If the front of an advanced guard formed on a road is attacked, the leading files will at once fall back on their support; the commanding officer of the guard will then use his discretion in ordering his reserve to move up and reinforce the support, or the support to fall back on the reserve, according to the nature of the ground, the strength of the attacking party, and the distance he may be from the main body; remembering always that his principal duty is to give time for the column to prepare to receive the enemy, without unnecessarily exposing his own men.

Formation of an Advanced Guard on a Road.

When a column is marching along a road, the advanced guard should be composed of one or more companies, divided into four parts or sections; the two rear sections (under the command of the senior officer) form the *reserve* in front of the column; the second section from the front will form a *support* 200 yards in front of the reserve, under the command

of the third senior officer; the leading section should be 100 yards in front of the second section, and should detach a corporal and two files 100 yards to its front and two files to each flank, 100 yards from the road and about 50 yards more retired than the corporal's party. The senior subaltern accompanies the leading section. Single files of communication are placed between the different divisions of an advanced guard, and also between its reserve and the head of the column. The distance between the two latter must be regulated by circumstances; but it should generally be about 500 yards during the day, and about 300 during the night.

The detached files are intended to examine all houses, enclosures, &c. within their reach. If the company is weak it may be advisable to send on only one file and a corporal in front, and one file on each flank.

Method of Forming the Guard.

The simplest method of forming an advanced guard is to draw the company or companies up, in column of four sections or parts, in front of the main body, and then march off the different parts in succession, commencing with the corporal and two files who are to lead. If the right is in front, the movement should commence from the right; if left is in front, it should commence from the left of the leading section or part. The connecting files in front of the reserve should be sent on from the

reverse flanks of the second and third parts or sections, the connecting file in rear of the reserve should be dropped from the pivot flank of the rear section; one connecting file should be sent out from the leading company of the main body.

Having laid down the directions which are necesssary for carrying out the "seven things" mentioned by General Napier, as a similar *limited* amount of drill has been recommended in the War Office Circulars which have recently been issued on the subject of Rifle Volunteers, I shall not attempt to add another movement. In those Circulars it is distinctly stated, that "it should not be attempted to drill or organize rifle volunteers as soldiers expected to take their place in the line, which would require time for instruction that could ill be spared; but it should be rather sought to give each individual a *thorough knowledge* of the *use* of his weapon, and so to qualify the force to act efficiently as an auxiliary to the regular army and militia, the only character to which it should aspire. The instruction, therefore, that is most requisite is practice in the use and handling of the rifle, with such further instructions, as sharpshooters, as it may appear desirable to give them—namely, how to extend and avail themselves of cover, to fire advancing or retiring, to protect themselves from cavalry, or other simple movements, which, while

leaving every man his independent action, would enable them to act together with more effect." But above all, "volunteers should be amenable, when called upon to act, either in garrison or the field, *to military discipline;* for without such discipline no General or other officer under whom they may have to act will be able to place much dependence on their assistance or co-operation in the hour of need."

PART III.

CHAPTER I.

ON CLEANING THE RIFLE.

Names of the different parts of the Lock.—To take the Lock to pieces.—To put it together again.—Washing the Barrel.—Examination previous to Ball Firing.

As correct shooting depends entirely on having the rifle always in first rate order, the impossibility of performing accurately with it, when dirty, cannot be too strongly impressed on the mind of the rifleman.

The *Lock* does not require to be taken off every time the rifle is used, but it is advisable to look at it now and then, more especially, when the rifle has been used in wet weather, and, with a feather or small fine brush to wipe off the old oil and to put a little fresh oil on the parts where there is any friction. A small bottle of prepared oil, which will last a long time, may be purchased in any gun-shop. The soft pleasant action of the hammer, and lively click of the sear as it falls into the tumbler, should be carefully attended to; when these are not satisfactory, the lock should be taken off and examined.

Before removing the lock, place it on half-cock, and lower the hammer immediately after the lock has been removed.

In the event of the lock requiring to be taken to pieces, for the purpose of being thoroughly cleaned, it might be advisable to send it for that purpose to a gunmaker, but as a clever rifleman would most likely prefer attending to this himself, the following directions will enable him to take it to pieces, and, after cleaning it, to put it together again; the different parts of the lock will, however, be first described, in order that no mistakes may be made in its dissection.

1st. *The Main-spring* is the large spring by which the tumbler and the hammer are worked.

2nd. *The Tumbler* is the centre piece which moves with the hammer, and in which are the bents, or notches, where the sear catches at half and full cock.

3rd. *The Bridle* is a piece of steel which covers the tumbler, and in which the tumbler works; it is fixed to the lock-plate at the top by two screws called the bridle screws, and at the bottom by another screw called the sear screw.

4th. *The Sear* is that part which catches the tumbler at half and full cock, and which the upper part of the trigger pushes up to discharge the rifle.

5th. *The Sear-spring* presses the sear against, and holds it in the bents, or notches, of the tumbler, for either half or full cock.

6th. *The Swivel* is a crooked bit of steel, some-

what like the letter S; it is attached to the tumbler at one end, and at the other it receives the end of the main-spring.

7th. *The Detant* is a little piece of moveable metal attached to the tumbler to prevent the sear from catching at half-cock when the trigger is pressed; it keeps the sear from going into the half bent until the hammer is let down and drawn back again.

8th. *The Tumbler Screw* is the screw which fastens on the hammer.

In taking the lock to pieces, proceed as follows: 1. Place the lock on full cock; take the spring-vice and cramp the mainspring, screwing the spring-vice gently, just sufficient to give the hammer a little play; let down the hammer, and the mainspring will be easily detached from the swivel and seat in the lock-plate. It may be advisable to let the mainspring remain in the spring-vice until it is again replaced, as cramping the mainspring, when it is off the lock, is a somewhat difficult matter to the uninitiated. 2. Place the lock on half-cock, and unscrew the bridle screws, and then the sear screw, and be careful not to mix them. 3. Take off the bridle, and then the sear. 4. Unscrew and take off the sear-spring. 5. Unscrew and take off the hammer. 6. Take off the tumbler, and then the swivel and the detant.

When the lock has been taken to pieces, wipe the different parts, first with an oiled rag, and then with a rag quite dry. If any spots of rust appear,

either in the lock plate, more particularly in the tumbler axle hole, or on any of the different parts, they should be removed with the oiled rag. No cleaning powder of any kind should be used for this purpose, as such would destroy the case hardening of those parts that are not steel, and make them more liable to rust. In putting the parts of the lock together again, the threads of the several screws, as also the pivot and axle of the tumbler, and the pivots of the swivel, should be oiled before putting them in their respective places, in order that they may work easily. The other frictional parts of the lock to which oil should be applied are the nose of the sear, and between the sear and sear-spring. Only a very small quantity of oil should be used, and applied either with a small bit of feather, or the point of a pricker, as too much is apt to clog the parts.

In taking a lock to pieces, and when cleaning the different parts and putting them together again, use a pair of old gloves, to prevent the warmth of the hands from causing rust.

In putting the parts together: 1. Put in the tumbler and swivel; driving the axletree home by using the handle of the screw-driver, and striking it a few gentle blows; then screw on the hammer and put on the detant. 2. Screw on the sear spring. 3. Put in the sear in its place. 4. Fix on the bridle, with the two screws and the sear screw. 5. Let down the hammer; hook the end of the mainspring on the swivel, and move it up into its

position on the lock-plate; unscrew the spring-vice, and the lock will be complete again.

If the mainspring has not been left in the spring-vice, place it in its seat on the plate, and then draw the limbs together by the spring-vice sufficiently to allow the end being put into its place on the swivel; the hammer being down. Never confine the mainspring closer than is absolutely necessary, as it will soon weaken and spoil it. In order to ease the springs, the hammer should always be let down upon the nipple, when the rifle is not in use.

The barrel should be thoroughly cleaned every time the rifle is used, and in proceeding to do so, first take out the ramrod, and unscrew the muzzle end of the sling, then place the lock on half-cock, and draw the bolt, when the barrel will be easily removed from the stock. Unscrew the nipple, as by doing so a greater stream of water can be forced through the barrel, by which means the cleaning is more thoroughly and expeditiously effected; besides, it affords an opportunity for removing from the nipple the first approaches of corrosion, before any injury is inflicted.

Place the breech end of the barrel in a pail or large jug, half full of cold water, and, with a soft brush attached to the cleaning-rod, work it up and down a few times, to loosen the filth from the lands and grooves of the barrel. Then, with a sponge or piece of cloth attached to the cleaning-rod, work it

again well up and down until the water runs off quite clear; after which, place the barrel in some clean hot water, and work the sponge or cloth for some time longer, until the barrel is perfectly free from all impurities.

This operation completed, blow strongly into the nipple seat; then turn the barrel downwards, and let it drain off for a minute or so; then work it dry with one or two bits of clean rag. This will very quickly be effected in consequence of the heat left in the barrel by the application of the hot water, as the heat will drive off any moisture that remains, and facilitate the penetration of oil into the breech and nipple seat.

Put an oiled rag on the worm of the cleaning rod, and pass it up and down several times, so as to leave the inside of the barrel in a moist state; then rub over the outside with the oiled rag until every part is perfectly clean and free from rust.

An excellent grease for this purpose may be made of two parts (in weight) of good olive oil, and one part of mutton fat. Melt the mutton fat and strain it through a thin piece of linen or calico, after which mix the oil with it. This will produce a grease of the consistency of a pomatum, which should be kept carefully covered to preserve it from dust.

Before using the rifle again, take a piece of dry cloth and wipe the barrel clean out; and, on arrival at the practice ground, before loading with a bullet,

snap a cap, in order to ascertain by the sound if the nipple and anti-chamber are clear, and in proper order for shooting.

The nipple should not be used after the hole has become large by repeated firing, as the great escape of the gases by it is apt to injure the lock, by forcing the hammer up to the half-bent. The escape of the gases by that passage has also the effect of very materially lessening the power of the charge, and consequently, the range of the bullet.

It would be advisable to have the breech taken out and examined during the course of the season, when the interior of the barrel could also be examined; but this had better be done by the gun-maker, unless the rifleman's mechanical powers and means will enable him to do it properly. In unscrewing the breech, great care should be taken not to wrench it, or the threads of the screw may be completely destroyed. Clean the threads, and oil them well, before screwing the breech in again.

In cleaning a military barrel, which is not made with the intention of being taken from the stock every time, care should be taken in pouring the water in, to prevent any of it getting between the stock and the barrel, or into the lock through the tumbler axle hole. A little bees-wax applied between the stock and the barrel, and between the lock plate and the stock, will prevent the water getting under the barrel, or into the lock by the edges of the plate.

Rust in the barrel, is caused by the joint effects of moisture and air; the surest way, therefore, to prevent it, is to keep the bore perfectly dry, by putting a muzzle stopper in, and a snap cap on the nipple, to exclude all air.

Chapter II.

ON CASTING BULLETS.

The Mould.—The Lead.—The Corrector.

In giving an order for a bullet mould to be made, care should be taken that it is not formed so as to have the lead poured in at the front, as the cutting there, for the purpose of removing the castable, or neck, destroys the symmetry and smoothness of the anterior part of the bullet, which it is so desirable to retain. All who have a correct knowledge of the effects which the friction and resistance of the air have upon projectiles, will readily conceive how far a little roughness or irregularity, on the anterior part of a bullet, may cause it to be driven from the true line, especially at long distances.

In casting bullets, use an iron pot in which to melt the lead, and a small iron ladle for taking it out of the pot and filling the mould. Do not melt more lead than is intended to be used at one time, and take care that it be neither too hot nor too cold, for if the lead be so hot as to boil like water, the bullet will be too light and hard, and if it be too cold the lead will not run so as to fill the mould

sufficiently, and of course the bullet will be too small.

When the lead begins to melt in the pot, put in a little bit of tallow, and stir the lead up with the ladle, when the scum and dirt will rise to the top, which, of course, must be carefully skimmed off. The molten lead will then appear quite clear, and fit for use. Keep it in the same temperature by placing the pot in a proper place on the fire; for if it becomes too cold and requires to be melted over and over again, this repeated melting of the same lead will harden it like pewter; whereas, good shooting bullets ought to be soft and even in composition, which cannot be the case, if care is not taken to keep the lead in an even temperature at the time of casting.

When commencing, it is requisite to make two or three preparatory castings, in order to heat the mould generally; and those bullets first cast should be thrown back into the melting pot; as the bullets are only fit to be retained when the mould is sufficiently heated, and the lead in the pot is at a sufficiently high temperature.

Be careful to keep the mould *quite close* when pouring the lead in, otherwise a difference in the size of the bullet will be the result. This is often the case when castings are made in too great a hurry.

If, in casting, any lead be left about the mould that may prevent it from closing exactly, never use a steel or iron blade, but remove the

lead with a wooden scraper, in order that the shape of the mould may not be injured.

During casting, the mould will frequently become so hot that the lead will not fit as it ought to do, or the bullet will become hollow. In this case the mould may be put into cold water, closed with a bullet in it to prevent the water getting in, and then wiped dry, to prevent the lead flying in your face when you cast again. If you have made the mould too cold by putting it in water, hold it to the fire, or cast another waste bullet in it; for if it is too cold the lead becomes chilled, and the bullet will be too small and too light. The great art is, therefore, to keep the lead always as near as possible, at the same temperature, and the mould at an equal heat. It is also better to keep the ladle in the pot when not in use, to prevent it from getting too cold.

Bullets must always be regarded as defective when their shape is not smooth and *clearly defined;* all rough and misshapen ones should therefore be rejected. It is a good plan to have a short piece of smooth barrel of a proper calibre to pass the bullets through after the casting is over, when all that do not fit nicely should be put aside, for bullets cannot be cast too true for rifle shooting. Those which are rejected may be set aside until another casting takes place, when they may be put in the melting pot with the new lead.

Great care should be taken that neither pewter, tin, nor plumbers' solder, be mixed with the lead

purchased for casting rifle bullets, as they will be much more difficult to get down the barrel, from their hardness, if they be made to fit as close as they ought to do; besides, they, in consequence, will not expand into the grooves so readily, and, of course, will not range so far nor so true. The lead should be quite pure to ensure good bullets, and perfection in shooting with the rifle.

Mr. Greenfield, of Broad-street, has contrived, what he calls, a "Bullet correcting machine," one, or more, of which should be in the possession of every company of Volunteers. The use of this cheap and portable machine is to ensure correctness in the size of all kinds of cast bullets, whereby the inconvenience experienced from tight fitting bullets is entirely removed, and greater correctness of shooting produced. "*Directions*:—Place the cast bullet in the mouth of the die, press down the handle which will force the bullet through."

The dies may be made to any size, according as the bullet is intended to be used in a *naked state*, or with paper wrapped round it. The moulds for casting the bullets, in these cases, should be made the *slightest* degree larger than the dies, so that when passed through the machine, the bullets may be all of the *full* size.

CHAPTER III.

ON VOLUNTEER EQUIPMENT

Clothing—Accoutrements, &c.

"Popular error," Colonel Gawler very justly remarks, "ought to be corrected in regard to *colours* suitable for light infantry, by the plain matter of fact, that skirmishing is not in general a prowling, wolf-like proceeding, but sheer hard and open fighting; in which, indeed, the parties engaged make the best of any cover that presents itself, but in which also *the flashes and smoke alone* presents marks for reply that no tint of uniform can conceal. In concealing cover, *not the coat*, but the *head dress* and *face* are seen. It is a reasonable subject of doubt whether on open ground, at a distance of 600 or 800 yards, red, soiled by dust, dirt, and drenching, does not mellow into a greyish purple, as little calculated to make the man who wears it a mark as blue, black or dark green. Take away white epaulettes, white lace, and white belts, and the red jacket itself may still continue to be, with prudence and propriety, the leading star on land of England's high honour and prosperity."

The truth of these remarks must be apparent to

all who have ever practised rifle shooting at long ranges, or who have had opportunities of seeing military men, in every variety of costume, moving about near the targets. At even 200 yards, bright gilt buttons and gold lace are so blended together as to appear a mere patch of yellowish colour. From 300 to 400 yards, scarlet facings may be traced, but at 500 yards they cannot be distinguished by the naked eye. If we could invent a gunpowder that would not produce *white* smoke, we might then talk, with some degree of propriety, about adopting some of the absurd ideas which have lately been promulgated on the subject of clothing for volunteers; but until that has been accomplished, it matters very little what the colours of the clothing may be, for the *whereabouts* of a rifleman will always be betrayed by every puff of smoke he raises, which at long ranges is as good a mark to aim at as any six foot white cloth target, behind which a rifleman may be lying.

With reference to appointments, &c., Colonel Gawler further remarks that "the weight of the ammunition and bayonet has hitherto, in regard to the infantry in general, been supported upon the shoulders, and that of the former concentrated on one point. It would appear very possible to divide the support between the shoulders and the waist, and to distribute it equally around. The thirty inches of space which, in general, surround the waist of the full-grown man, would allow of sixty ball cartridges, placed side by side perpendicularly

in four flat well-made pouches, one on each side before, and the same behind. These might be attached to a waist-belt clasping in front, and supported, moreover, by a few stout buttons in the coat, and by a pair of very light belts, in the general form of common braces, crossing on the back, but in front falling straight down from the shoulder without crossing, and terminating each in two points. The material for all these belts might be leather, and the colour, that very common tint, reddish brown, to assimilate with the coat."

"The advantage of this arrangement would be that, in addition to the weight being equalized, the soldier could, as he pleased, ease his shoulders by tightening the waist-belt, or ease the waist by loosing the clasp. He would be also free to throw wide open the coatee in opressive weather, or in falling out on the line of march. Than this last, there could not perhaps be a greater relief to the practical soldier.

"In a campaign, a man might conveniently carry, in addition to this ammunition, thirty rounds of gunpowder in a stout well made flask, hung by a strap over the shoulder, and a bag with thirty bullets, in greased paper, on the right side of his waist-belt, to balance the sword-bayonet, suspended from a frog on the left side. For long ranges, loading from the powder flask might be safe and convenient —the cartridges would serve for closer quarters.

An "officer of the line," observes with regard to clothing, that "it should combine in the highest

degree suitableness and economy. Volunteers should be dressed in uniform; neither "*esprit de corps*," nor *esprit militaire*," would be kept up without it. Doubtless men could fight as well in their *shooting jackets* (as a great authority suggests) or in their shirt sleeves on an emergency; but, for discipline and combined movements, they should dress alike. We want no bright conspicuous colours—no brass — no plating — no pipe clay —no patent leather stocks—no heavy knapsacks. A brown, or lightish green cloth tunic edged with red, with strong curb chain shoulder straps. Trousers of the same material, with a cord or narrow stripe of red. A light helmet, not bright, but to match the dress as near as possible. Leather waist-belt, with two cartridge pouches to slide either before or behind at pleasure. These, with a good rifle and sword bayonet, would complete a dress, with all the requisites of usefulness, suitableness, and economy."

A writer in the *Times* very truly observes, with respect to the *colour* of the dress, that "it is a question whether it is so important to have what are called 'invisible' colours, as to have one by which all the troops of one army may be easily distinguished at a distance. In deer-stalking you wish to remain unseen till you have delivered your fire; but in action you have to be fired at afterwards, and then the flash and smoke of your rifle will always show where you are. I admit that a man dressed in some variety of grey is not a good mark at a distance, which varies with the clearness of the

atmosphere. But troops can never be invisible except behind solid protecting cover; and then, of course, colour is of no consequence; while even in open country it is not always easy to tell to which army troops suddenly appearing on your flank may belong. How much more, then, must this difficulty be increased in an inclosed and broken country, where volunteers would be most useful?"

According to our highest authorities, the uniform for volunteers may be plain, but it ought to be of a *decidedly* military character. If the members are to be taken from the lower classes of society, the costume may be plain and cheap in the extreme; but, if *gentlemen* are expected to come forward, the dress which they are required to wear must be *gentlemanly* as well as serviceable. Young men, ay, and even their elders, who will compose the *Reserve* sub-divisions, will make all the better soldiers for shewing to advantage in a soldier's dress, and, besides, unless a distinctly military character is assured, volunteers might be unable, in the event of active service, to obtain the recognition due to *bona fide* soldiers. This observation applies with equal force to conditions of organization and discipline. It is truly remarked in the War Office Circular, that without a concerted amount of discipline, volunteers would be useless, and it must be further remembered, that without this organization, they could not get the benefit of the laws of war. In any country which is a seat of war, a man with arms in his hand can only justify his proceedings by

proving that he his a soldier. If he cannot prove this, if he is not *evidently* an authorised combatant, he is liable to military execution, as we see by the Proclamation which was lately issued in Italy. There must, therefore, be no obscurity about the true military character of volunteer riflemen. They must be part and parcel of HER MAJESTY's land forces, though organized on special principles and as *Smartness* is a first rate military quality, it would be unwise to neglect any consideration which may tend to inspire self-possession and self-respect. There need not be any extravagance in the matter, but soldiers have never been the worse for being well dressed, and a costume may be made both attractive and handsome without being any the less useful.

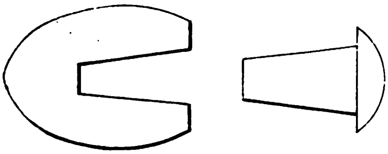
The question of uniform and general equipment is, in fact, of far more importance than may appear at first sight in an age which has abolished epaulettes and gorgets, which laughs at the LORD MAYOR's carriage, and has substituted plain tunics for the gorgeously embroidered doublets which were formerly worn by the Warders in the Tower. There is in many quarters, I admit, a well founded objection to unnecessary sumptuary display, to gingerbread finery and party coloured masquerading when practical duties have to be performed; but this love for plainness and sobriety of attire may be carried too far, and is dangerously apt to degenerate into Quakerism. To tell the truth, this rifle shooting is but an apprenticeship to the great trade of man killing, and that is a craft requiring some little

dressing to disguise its abstract horror. Slaughter, or its simulation, without some moderate amount of drumming and trumpeting, must be repugnant and abhorrent to every heart in which glows a spark of humanity; and if the very simplest and most convenient costume that exists were adopted by soldiers, our Guards would go forth to battle in the blue frocks of butchers, and with their sleeves tucked up to their elbows.

Let there, then, in the name of common sense, be no peacock finery, but let us have a sufficient amount of military smartness and military gaiety in the costume. We dont want legions dressed in the fantastic array of the American Volunteers, the "Boston Tigers," the "Syracuse Scorpions," or the "Mississippi Fire-eaters"; but we may well shudder at the notion of having swarms of English Riflemen, dressed in hodden grey and wide-awake hats, half convict, half plough-boy looking. It is easy to combine taste and elegance with practical utility. A general key-note of colour, a margin of appearance, must be established, and minor detail and ornamentation may be safely left to the good taste of those to whom the Lords Lieutenants of Counties may be pleased to confide the training and drilling of our volunteers.

Note.—On the 1st of July, the Secretary of State for War, said, in reply to a question from Lord Elcho, that there was nothing to prevent the members of volunteer corps from supplying themselves with arms, *provided they were of the regulation guage.* Any style of *grooving* (*see* page 46) which improves the shooting of the rifle, will, therefore, be permitted.

Fig. 1.



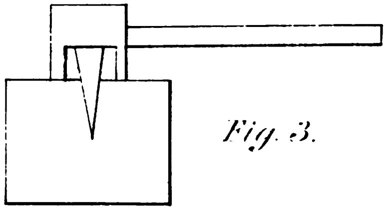
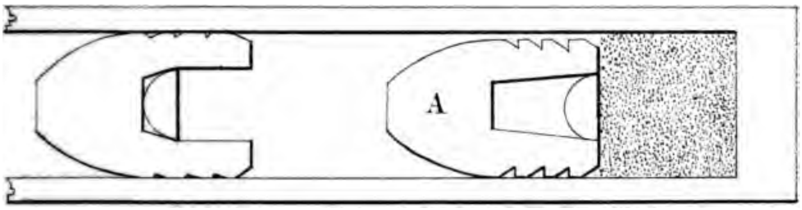


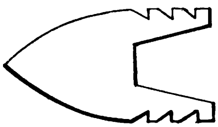
Fig. 3.

Fig. 2.



Figs

4. 5.



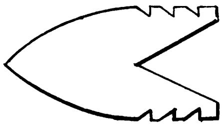


Fig. 6.

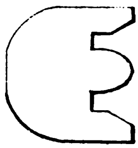


Fig. 7.

A. B.

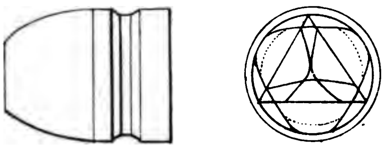


Fig. 8.

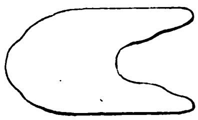


Fig. 9.

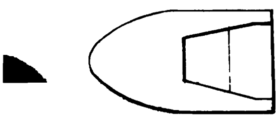
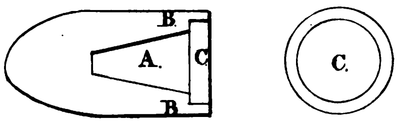


Fig. 10.



LECTURE I.

FIELD-MARSHAL
HIS ROYAL HIGHNESS THE PRINCE CONSORT, K.G.,
&c. &c. &c.,
IN THE CHAIR.

ON THE RISE AND PROGRESS OF THE "MINIE EXPANSION" SYSTEM, AND THE MISTAKEN NOTIONS WHICH IT HAS UNHAPPILY ENGENDERED; INCLUDING REMARKS ON THE RIFLE PROJECTILES OF DIFFERENT COUNTRIES.

IN taking a cursory view of the rise and progress of the "Minié expansion" system, and the mistaken notions which it has unhappily engendered, it is not my intention to enter into any arguments of a merely controversial character, or to question the claims of any person to the merits of the invention. On the contrary, I intend to show that I can prove, by the aid of experimental facts, that the whole system is a fallacy; that the doctrines and principles, which its authors have framed and imbibed, are not illustrated in the practice of the system itself; and that, conse-sequently, they are erroneous and false. And, more-over, I mean to show, that the practice of the system not only encourages the growth of false principles in

gunnery, but entails a most unnecessary expense on any Government that adopts it.

The "Minié" principle, as at present understood, was practised in England before it was imported from France; but as it is generally supposed to be of French extraction, I shall commence by glancing at what led to its partial adoption in that country.

In 1826, Captain Delvigne, an officer in the French service, turned his attention to improvements in the rifle; his principal object then being, "to facilitate loading."

His first suggestion was the "chamber breech," which still bears his name. In the breech of the barrel a chamber was formed of less diameter than that of the barrel, having a shoulder resulting from the difference of the calibre of the barrel and the chamber. Passing freely down the barrel, the spherical ball reached this shoulder, where it rested; the powder being previously introduced into the chamber beneath. Two or three smart blows of the ramrod on the ball, expanded it sufficiently into the grooves of the barrel; but, in so doing, they had the disadvantage of driving a portion of the ball into the chamber, which very materially altered its shape.

After labouring for some years with the spherical ball, Captain Delvigne, in 1830, tried an elongated bullet, with which he obtained very favourable results; but the Central Commission of Artillery insisted on the retention of the spherical ball, whatever the other modifications in the arm might be!

In 1840 he again ventured to introduce a bullet

of an elongated form, "in order," as he says, "to increase the range and the correctness of the fire, by increasing the weight of the projectile, and by diminishing the resistance of the air relatively to that weight." The bottom of this projectile was flat, the body cylindrical, and the front part terminated with a conical point.

In 1841 Captain Delvigne tried a hollow projectile: "the hollow being introduced into the larger extremity of the ball, for the purpose," as he says, "of carrying the centre of gravity further forward." He adds, that "the ball may be forced by the stroke of the ramrod, or by the action itself of the gases in the *hollow* and *posterior* part of the projectile, by *dilating* it."

With respect to the elongation of the bullet, Captain Delvigne laid no claim to being its inventor, but simply to that of reawakening the attention of the military world to the serious study of that form in connection with his novel system of forcing the spherical ball—his replacing the latter by the former. In fact, he distinctly says, in speaking of his own projectile, that "a bullet made in Switzerland, which he had either *seen* or *heard* of, was the only one that bore any analogy to his that he was aware of." Who was the original inventor of the *fundamental principle* of the present rifle projectile—the *elongated* form, it is now impossible to say. All we know is, that it can be traced back, through various modifications, to the time of Henry V., in 1413, when "elongated shot of three and four calibres in length, were fired

from small cannon." Indeed, it is more than probable that they were formed in imitation of the bird-bolts, or other projectiles which were then used in archery.

Previous to the last-mentioned date, Mr. Greener, a gunmaker, now of Birmingham, had contrived a bullet on what he calls the expansion system, by plug agency. This contrivance I intended to have passed over with a very brief remark, in order to arrive the sooner at Captain Minié's plan; but as Mr. Greener has lately announced to the world, through the medium of the public press, that he is not only the inventor of this projectile, but that Captain Minié borrowed his idea from him, it will be necessary to place both contrivances side by side, as the same falsity of principle which applies to the one applies also to the other.

It may, however, be advisable to go on tracing the various modifications which took place in France, until we arrive at Captain Minié's invention, and then return to Mr. Greener.

In 1844, Colonel Thouvenin, of the French Artillery, presented his modification of Captain Delvigne's mode of loading by flattening the projectile. It consisted in the application of a cylindrical *tige* or pillar of steel, screwed into the breech in the centre of the barrel—so that the bullet, when stopped by and resting on the flat end of the pillar, received, directly opposite the blows of the ramrod sufficient to effect the forcing, as in Captain Delvigne's mode of loading. This contrivance constitutes what is called the

carabine à tige. The advantages considered derivable from this modification were, the suppression of the chamber, a *sabot*, and other accessories, as the upper end of the *tige* alone furnished a firm basis to the bullet.

In consequence of the removal of the "chamber," and the introduction of the *tige*, Captain Delvigne now abandoned his idea of forcing the projectile *by the action of the charge.*

The question of rifled pieces appeared now, in France, to have received its final solution. The range, the precision, the simplicity in loading, seemed to have reached the highest possible point, and several years thus passed away, when suddenly the subject entered a new phase. The forcing of the bullet by the gases alone—the very means suggested by Captain Delvigne, though in a somewhat different manner—was applied to the elongated projectile by Captain Minié, who, it is admitted, "added *no greater precision or range* to those already existing in *tige* guns, though he certainly simplified the loading and manufacture."

In 1849 Captain Minié had remarked that, owing to several circumstances, the forcing of the ball in *tige* guns was often irregular, and that, whatever precautions might be taken, these irregularities always existed in a variable degree. He then "hit upon the idea," it is stated, "of using, in forcing the ball, the gases developed by the explosion of the powder." The ball which was then adopted in France had a truncate-conical cavity in its base: at the orifice of this hollow he fixed a little cup of iron, which ap-

proximated in shape to the form of the cavity. The ball descended freely as far as the powder; and "on fire being communicated to the charge, the gas developed acted powerfully on the little cup, and caused it," as Captain Minié says, "to penetrate deeper into the bottom of the ball, and, in consequence, effected the forcing against the sides of the barrel."

Returning now to Mr. Greener, we find that he had previously tried a bullet on the "expansion" system, by the agency of a plug, as represented by Fig. 1, but which he meant to apply to smooth-bore guns only; as, at that time, and for many years after, he completely ridiculed the idea of rotatory motion being desirable round the longest axis of a military projectile!

With reference to this bullet, Mr. Greener addressed a letter to the editor of the *Times*, in 1841, in which he says, "Some years ago I laid before the Board of Ordnance a very simple plan of getting rid of all windage, yet of loading easily and adding to the weight of the projectile. This was effected by employing an oblong ball of lead, a diameter and a half in length, having a perforation extending through two-thirds of it. An iron plug of a conical shape is slightly inserted into this perforation, and the gun loaded with it. When the explosion takes place this plug is driven home into the lead, and, by expanding its outer surface, the projectile comes out of the gun fitting as tight as possible, and a line of flight is given to it of corresponding accuracy. But the authorities laid the plan on the shelf, where it will rest until

produced by some more important personage than myself."

This method of attempting to expand the ball was, however, nothing new, for Cibrario informs us that, at the end of the 17th century, "both spherical and elongated balls of lead were fired, having *stone kernels* placed in them for the purpose of expanding them and decreasing the windage." This system, like others which have no correct principles to rest upon, must have fallen soon afterwards into disuse, for its practice cannot be traced about the beginning of the 18th century.

Mr. Greener, as we have seen, met with no encouragement from the Board of Ordnance on his first application; but, in 1842, he a second time brought his contrivance forward, in what he called an improved state. It was, however, again rejected by the Select Committee, and I think most deservedly so.

Mr. Greener informs us, that " when the explosion takes place the plug is driven home into the lead, and by expanding its outer surface the projectile comes out of the gun fitting as tight as possible, and a line of flight is given to it of corresponding accuracy." In like manner, Captain Minié says, that " on fire being communicated to the charge, the gases developed act powerfully on the little cup and cause it to penetrate deeper into the bottom of the ball, and, in consequence, effect the forcing of the latter," as represented by the copy of a French sketch, Fig. 2.

Here we have the whole machinery of the system laid open before us, and explained according to the

belief of its authors; but they point to no corroborative facts in support of their mere assertions. They believed, no doubt, in what they have asserted, but it is quite clear that they could not have studied *cause* and *effect* in this instance with sufficient care. Contenting themselves apparently with simply *supposing* what the laws of nature should be in such cases, they have looked only at such results as *appeared* to them to square with their *hypotheses*.

The principles of the system, as here set forth, have been quoted and copied as established facts by many talented writers, solely because they relied on the faith of others—on the reports of those who should have known better. Many ingenious men have thus also been led to attempt modifications of the same system, by contriving iron cups of various forms, moveable metal and wooden plugs, cavities of varied construction, &c., in the hope of making the practice more correct and regular than it was found to be with the original "Minié" cup.

Some of the gentlemen whom I have now the honour of addressing may have hitherto had their attention more particularly directed to the practice of gunnery with shot formed of *iron*: it may, therefore, be desirable, before we proceed further, to reflect, just for a moment, on the *nature* of the substance of which a rifle projectile is composed.

LEAD is a soft, flexible, and inelastic substance. It is malleable and ductile, but inferior to all ductile metals in tenacity. If the atoms (or the exceedingly minute resisting particles) of which it is composed be

displaced by a superior force, there is no tendency in them to regain their former positions, as in elastic bodies; they, therefore, remain passively in the new positions they have been forced to take up. The atoms cohere equally in whatever relative situations they may happen to be, and therefore yield to force, or the repulsion of the gaseous particles which are generated by the ignited powder, and shift about among each other almost like the atoms of a fluid. Lead, like wood, may be pierced with a sharp instrument, which will push away the particles to one side and the other, but to no great distance; that portion close to the instrument being rendered only more *dense*.

If we take an elongated hollow bullet, and lay it on the edge of a bench, or a block of wood, with its base outwards, and then strike it smartly with a mallet, the outer half of the bullet will be expanded, and made shorter, but the other half will not be affected at all. This fact is easily explained, by simply saying that the atoms, or particles, of the lead, which compose the outer end of the bullet, are driven on the others, before the *inertia* of the more remote atoms are overcome. The consequence is, that in pushing one another aside the atoms are pushed in all directions, some outwardly and some inwardly, but all then moving rapidly onwards: the *inertia* of those in front having at last been overcome.

The blow with the mallet is only intense and brisk *pressure*, suddenly begun and terminated. The action of ignited gunpowder is also pressure, but in

a *graduated* and much more powerful degree. In the latter case, the expansion of the lead would be restrained within certain limits by the sides of the barrel; and the fore part of the bullet would be altered in shape by the resistance of the condensed air, but only after it had passed up some portion of the tube.

It is said by the advocates of the "Minié" system, that "the cup or plug acts like a *wedge*, and, on being driven in by the explosion, forces the sides of the cavity outwards." This is a very plausible doctrine on which to build such a system; but it is a very erroneous one. Those who compare the action of the cup or plug to a wedge, must be totally unacquainted with the real action of the gunpowder and the bullet *inside* the barrel; for such a theory is not only inconsistent with the doctrine which has been laid down by the highest authorities on the subject of gunpowder, but it is opposed to the evidence which experimental inquiries have brought to light with regard to the *movements* of the bullet: it is, in fact, tantamount to saying, that the force of the explosion is concentrated on the *end* of the cup or plug alone, and not let loose with equal force on the entire hinder end of the bullet.

If, for example, we were to insert a wedge into a block of wood, and then take a large mallet, having a cavity in it deep enough to allow the head and body of the wedge to enter, as represented by Fig. 3, we might strike for ever without making the wedge enter deeper into the block, as the face of the mallet would come in contact with the block at the same instant

that the head of the wedge came in contact with the bottom of the cavity in the mallet; in fact, the only result would be, that the wood round the wedge would be rendered more dense by the repeated strokes, and the wedge loosened accordingly.

So it is with the force of the explosion on the end of a "Minié" bullet; though, in this case, the entire base of the bullet, plug, and lead gives way together, at the same time, to the expansive force of the powder: showing clearly that the lead does not remain passive while the plug is being driven in.

The most eminent men admit, that, though gunpowder explodes so suddenly as to appear a simultaneous burst of flame, it is, correctly speaking, not so, but merely the rapid ignition and combustion of all the particles; and that a portion of time is necessarily occupied by the flame, however short that portion of time may be, in travelling from the first grains to the last. It is also admitted, that as the combustion of the powder proceeds, it is decomposed, and produces gaseous bodies, which have a tendency to fill a much larger space than that occupied by the powder before inflammation. These gases, therefore, seek an outlet where there is least opposition; and this outlet, unless the gun be faulty, is the place occupied by the bullet.

This being the case, it must be evident that, as a part only of the charge is at first inflamed, the gases which are generated by *that* part must also find a vent before the rest of the charge is completely fired. Now, I have ascertained that the gases engendered by the smallest possible quantity of powder

are quite sufficient to overcome the *inertia* of the entire bullet, and to set it in motion, though not sufficient to press the particles of lead closer on one another. The fourth part of a grain of powder will drive a *properly* fitting bullet up the barrel a distance of three or four inches; half a grain will drive a bullet up a distance of eight or ten inches; and one grain and a half will drive it out of the barrel altogether. This being so, it must be obvious that the gases generated by the first inflamed portion of the charge will find a vent, by simply pushing the unburnt part of the powder, and also the bullet, onwards, while the rest of the powder is being ignited. The gases afterwards, as they increase by the successive ignition of the remaining portions of the powder, act more and more forcibly on the bullet, and cause it to exchange its first, but comparatively slow movement, for one of a very rapidly increasing motion.

This being admitted, it is satisfactory to know that the action of the bullet inside the barrel, as thus described, is also confirmed by the clearest evidence; for during the course of a very interesting series of experiments, which I had the pleasure of conducting, the truth of this theory was proved to the entire satisfaction of several parties who attended. The facts brought to light also proved, in the clearest manner, the falsity of the "Minié" system.

In the course of these experiments, and in order to test the theory thoroughly, some hundreds of rounds were fired, with various sorts of projectiles, and with different lengths of barrel, into water, clay,

and other substances, so that the bullets might again be collected for examination afterwards. The first number of rounds fired were from a rifle barrel 2 feet 8 inches in length. Then, after every stage of firing, from 3 to 4 inches were cut off the barrel, until it was shortened to one-half its original length. Two inches at a time were then cut off, until the barrel was shortened to one fourth; after which, one inch each time was cut off; and then half an inch, until the barrel was shortened close to the charge—a *full* charge of powder being used at every round. The result showed that, after a certain length had been cut off, the appearance of rifling on the bullet grew more and more indistinct, until not a vestige of it could be traced.

It would occupy too much of our time at present were I to attempt to describe a tithe of these experiments; but that part of the evidence which bears more particularly on our present subject may be summed up in a few words.

Beginning at the breech end of the barrel, it may be observed that, until the bullet had moved about half an inch, no perceptible signs of expansion had taken place, nor were there any traces of rifling on the bullet. Then, however, the faintest trace of rifling, like scratches, could be perceived, for about an eighth of an inch, next the base of the bullet. This impression showed itself more and more distinctly and at greater length as the bullet proceeded further up the barrel, until it appeared complete all along the cylindrical part. From the proofs which

were exhibited in the earlier stages, the compression of the bullet and the expansion of the lead into the grooves must have continued for some time after, though not discernible on the outside of the bullet. This opinion was confirmed by the action of hollow bullets, the cavities of which continued to be more and more *contracted* as the bullets passed further up the barrel. This was evidently occasioned by the increasing and accumulating pressure of the gases on the hinder end, and the resistance of the *condensed* air in front of the bullet.

From this it may be seen that a very slight degree of expansion, *if any*, takes place at the moment the bullet is moved from its state of rest, and that it is not *complete* until the bullet has travelled up some portion of the barrel: in fact, that the particles of matter which compose the hinder part of the bullet travel for some space of time, though infinitely short, and through some portion of the barrel, at a *quicker* rate than the particles that compose the fore part; the latter portion continuing to be driven up closer and closer on those which travel before, until the force of the gases have no longer any power to drive the particles closer together, the expansive force of the powder and the velocity of the bullet becoming then nearly on a par.

It will also be seen from this, that when the bullet is first moved from its state of rest, there is nothing whatever to derange the position of the cup or plug, or to cause it to act like a wedge. As the bullet proceeds, however, the accumulation of the

gases becomes a more powerfully propelling force, and consequently the condensation of the air in the tube in front of the bullet rapidly increases its resistance. The result of this is, that as the expansion of the lead into the grooves becomes more and more complete, so also does the expansion in the opposite direction inwardly—that is, the cavity becomes more and more *contracted* as the bullet proceeds up the barrel, and the force of this contraction loosens (or rather *squeezes*) the cup or plug out of its place, instead of its acting like a wedge; so that when the bullet leaves the muzzle, these contrivances fly *after* it indifferently to the right or left, but often to a considerable and dangerous distance.

The resistance of the *condensed* air in the barrel in front of the bullet, when in motion, is so great as to affect even the *form* of the front part of the bullet. In corroboration of this fact, I beg attention to the following manner of proof. Take a cylindro-conoidal bullet, having half its length *a fair cylinder*, and fire it into deep water for subsequent examination. On taking it out it will be found—if the bullet fitted nicely and the barrel was properly grooved—that *more* than half its length has become impressed with the marks of the lands and grooves. Now, how is this? We know that the tendency of the explosion is to press forward the entire hinder part of the bullet on the fore part, before the *inertia* of the fore part is overcome, and therefore to *shorten* rather than lengthen that part. But, on a careful examination, it will be found that it is a portion of the *conoidal* part that has

become marked with the grooves, and has been added to the cylindrical part which the bullet previously had. The explanation is this:—The air *in the barrel* becomes so highly condensed by the rapid motion of the bullet that it forms a strong spring, as it were; and resists the progress of the soft leaden bullet so much, as actually to press or flatten up the *front* part into the grooves, shortening and rounding that part and *adding* it to the cylindrical portion.

It is true that, action and reaction being equal, if a leaden bullet were fired into water at *too short* a distance, the front part would become flattened or rounded to a certain extent by the *sudden* reaction of the body fired into, and it would be more so as the force with which the bullet is impelled is greater. Nothing, however, but the action *inside* the barrel, could by any possible means impress the marks of the lands and *grooves* on the new part. In order to prove this beyond a doubt, I have, on many occasions, marked a bullet on the conoidal part, at a point which, when loaded, must have been one sixteenth of an inch from the lands of the barrel all round; and, on after-examination, I have found that *this very point* had been added to the cylindrical portion by the great resistance of the air, and was as well impressed by the lands and grooves of the rifle as any other part of the bullet.

It may here be remarked, by way of parenthesis, that in order to obtain good specimens of what a bullet is like on leaving the muzzle of the piece, the best plan is to have a tank of water, about ten feet

deep, placed at the side of a very high building—the higher the better—from the top of which the marksman should fire straight down into the water. A very simple framework of netting may be made and sunk to the bottom, for the purpose of bringing the bullets up from time to time. The impropriety of standing *too* near, when firing soft leaden projectiles into water or any other body, will be understood by those who have thoroughly studied the laws of "action and reaction."

Mr. Greener's ball, if it were made to fit ever so nicely, would only, in consequence of its *oval* form, touch the barrel at a point equally distant from its two extremities; and, at that point, on each side of the cavity, the lead is nearly as thick as the diameter of the cavity itself. Supposing, then, that the plug, "which is two-thirds the length of the ball," is actually "driven home into the lead" by the force of the explosion, experiments show that a *yielding* of the lead ·025 inch all round will be sufficient to admit the plug quite home. Now, experiments also show, that by driving an iron punch of a similar shape through a cavity of the same size, in a cylinder of lead of the same diameter, the particles of lead will retire or be driven back upon one another to a greater distance than ·025 inch, without increasing the diameter of the outer surface at all.

Mr. Greener's plugs are, however, more apt to be loosened and thrown out than driven in; but if a practical proof were wanting to show that they are not the "expanding agents" he supposes them to be,

let any man fire a *solid* leaden bullet, of the same shape, into deep water, and he will find, on taking it out, that it is as distinctly marked with the lands and grooves of the rifle as any of those with iron plugs: indeed, experiments show that such bullets are marked more regularly, and that the practice with them is better than with those which have cavities and plugs.

To show in like manner that the "Minié" contrivances are *not* "expanding agents," as they are called, let any man load with an iron cup or wood plug bullet, with its point next to the powder, and fire it, as before, into water; he will find, on examination, that it has been sufficiently expanded for any practical purpose. Let him even *throw away* the so-called expanding agents, and load and fire as before, with the point next the powder; he will find that the rifling on the bullet is equally good. So also Mr. Greener would have found, if he had thrown away his plugs, and filled the cavities, even with clay.

It should here be remarked, that the *sides* of the bullets, on which Captain Minié originally operated, and in connection with which he founded his theory, were much *thicker* in proportion to the diameter of the *cavity* than those we are now in the habit of calling "*Minié*" bullets; and, therefore, were even less subject to alteration in size, from any force acting *within*. This is a fact which, though overlooked now by the advocates of the Minié theory, should not have been overlooked then. The bullet in question is represented by letter A, Fig. 2, in the diagrams.

That "cups" and "plugs," and all such contrivances, are not "expanding agents" is a fact which is established by the most undeniable experimental evidence. The question then may be asked, what is the true cause of the expansion of the lead into the grooves? I answer, the highly *condensed* air in front of the bullet, when in motion; the *friction* on its sides, when passing up the barrel; the *inertia* of the fore part—that part of the bullet remaining passive, during its earlier stages, while the hinder part is being driven on it, by the force of the gases pressing behind. These are the simple, but unassisted, laws of nature; and are all, conjointly, the cause, *and the cause alone*, of the expansion of the lead into the grooves of the barrel. The most obstinate stickler for the "Minié" system will not venture to deny this, if he takes the trouble to look the facts boldly in the face, and draw his conclusions from them, not hastily, but deliberately, and in strict accordance with the evidence.

That some *leaden* bullets are "expanding," and others "non-expanding," according as they are hollow or solid, is a theory which appears to be gaining ground of late. It is, however, a very erroneous one; for it matters not what the shape of a leaden projectile may be, if elongated, for all will expand, from the simple cylindrical solid plug to the most elaborate hollow conoidal bullet, and the expansion will be more or less, according as the bullets are longer or shorter; or, in other words, the hinder part of the bullet will be driven up and rendered more

dense, in proportion as the projectile is longer; greater resistance in front being occasioned by the extra friction and *inertia* of the longer body.

We have seen that the resistance of the condensed air in the barrel is so great as to affect even the form of the bullet; what then must the *force* of the inflamed gunpowder be, which not only overcomes this resistance in about the two or three thousandth part of a second, but will cause a bullet to ascend perpendicularly a mile or more, before the force of gravity can overcome it? Yet, with such facts as these before us, and others which may be cited, the inventors and abettors of the "Minié" system will have us to believe that this enormous and uncontrollable force is concentrated and made to act on the end of the plug alone, while the lead itself remains, as it were, passive, like a block of wood in which a wedge is inserted! The idea is surely too absurd to be entertained for a moment by any scientific man, when once his mind is directed to the discrepancies which the theory and practice of the system display.

Though the *expansion* of hollow bullets, of the "Minié" pattern, without cups or plugs, is good enough for any practical purpose, the *practice* with them is generally very inferior. This seeming inconsistency I shall presently endeavour to explain.

In ENGLAND, at the time when the Enfield rifle was determined on, "trials were made of bullets with cups and also without cups, in order to ascertain the possibility of dispensing with the iron cup used with the Regulation and other rifled muskets. The result

showed that the practice of bullets of the regular 'Minié' form, with cups, was fully one-third better than that of bullets without cups; but," the report adds, "it does not follow that expanding bullets of other patterns should also require to be used with cups."

In AMERICA, about two years ago, the authorities, finding that "the balls, made according to Captain Minié's plan, did not succeed in their experiments, hit upon the expedient of hollowing out the bottom of the bullet, and making the edges *thin* enough to be forced *outwards*," as they erroneously believed, "by the action of the gas at the instant of the explosion of the charge, thus causing it to fill the grooves," as they thought, "and receive its rotatory motion." This was a return to Captain Delvigne's original but very crude idea of expansion by *dilatation*, and hence its failure; for the report goes on to say, that "it was found by experiment that this bullet, which weighed 310 grains, would not bear a charge of more than 38 grains of powder without being fractured or burst." "Experiments show," the report continues, "that the cavity in the bullet should be no larger than is necessary to give sufficient expansion to cause it to take a firm hold on the grooves of the barrel." Believing in such a theory (which is utterly groundless), a *larger* calibre was determined on, namely ·580 inch; the bullet was also made larger, but the cavity was made less in proportion, and a perfect cone in shape. Figures 4 and 5 show the form of both bullets.

In FRANCE, "while a commission was making ex-

periments with the 'Minié' ball, the idea was entertained of obtaining the expansion without the cup, like Captain Delvigne, by the sole action of the gases on the hollow. The first trials made with the ball, without the cup, allowed it to be proved that expansion *did* take place, and a certain precision was acquired, though far inferior to that of the cup ball.

These reports, it will be seen, are very similar in their nature, and the conclusions arrived at are nearly the same. Expansion is not denied; on the contrary, it is distinctly admitted that it did take place in the bullets without cups, though the shooting was very inferior. But it is somewhat remarkable that no examination was entered into, by either party, in order to ascertain if the inferiority of the shooting was due only to the *want* of cups, as *expanding agents*, or to some other and very different cause. This is a most important point, as connected with our present inquiry, and one which, when carefully examined into, throws great light on the defects and *want of truth* in the "Minié" principle.

Though cups and plugs are not "expanding agents," they are nevertheless very useful, but merely as *protecting* agents to the edges of bullets having deep cavities; and to this protection alone, and nothing else, do we owe the superior practice which is made with them.

The tendency of the explosion of the powder is, to drive up the *entire* hinder end of the bullet on the fore part, before the *inertia* of the fore part is completly overcome. All bullets, therefore, having

unprotected cavities—that is, without cups, plugs, or discs, to protect the *edges*—have their cavities made *shorter* and more *contracted* by the *forward* pressure of the gases. This has been clearly proved by repeated experiments, though many believe in the contrary. But this alteration in the bullet is not the only evil. The tremendous power of the gases, in rushing to find a vent, force their way sometimes between the barrel and the bullet: destroying the edges of the cavity, by forcing them *inwards*, and that in an irregular manner. I have many curious specimens of this sort in my possession; some of them collapsed like a wet glove, and others burst and blown into long irregular pieces of lead. Besides this, experiments also show that a *thin* edged bullet, on leaving the muzzle, has its edges often forced *outwards*, by the violence of the gases in their struggle to escape; making the edges ragged, and very unfit for travelling smoothly through the air.

Bullets like these, it may be easily understood, can never fly *true* to any distance; for the disfigured edge acts on the air like a damaged screw propeller against the water, and directs the point to any place but straight forward. For be it remembered, that a bullet has no steersman and rudder like a vessel, to correct the deviating tendencies which are sure to arise from such causes.

That such was the cause of the inferior shooting, which is alluded to in the English, French, and American reports, there cannot be a doubt on the subject. We have seen, indeed, that the Americans

found this to be the case; "their bullets," as they say, were fractured and burst, and the practice consequently was rendered very inferior." But instead of trying to find a better remedy, they simply and very unscientifically *lessened* the cavity, "making it a perfect cone in shape;" and thus, in part, strengthened its sides; forgetting that in so doing, they were bringing the centre of gravity further back than was desirable. Indeed, many of the inferior shots which are recorded in the American reports were doubtless the result of this cause, though attributed by them to the barrel, and the mode of grooving!

In FRANCE also Captain Nesler attempted to find a remedy for an evil, the true cause of which was not understood, by constructing the bullet represented by Fig. 6. "The first gases produced," he says, "on entering the hollow, press out the rear edge of the cylindrical part and force it against the sides of the barrel, so that, the windage being suppressed to the height of such edge, no strikings nor movements of rotation [in the direction of its motion] within the barrel are produced. Yet, as the anterior part of the cylinder of the projectile is not forced out, the ball might take boundings injurious to its accuracy; the nipple therefore remedies such inconveniences. In effect, that addition presents in the interior of the hollow a considerable projection on which the gases act with force, symmetrically and in all directions, whilst the projectile is in a normal position. These symmetrical pressures keep the ball in this position and prevent the production of the boundings, in the same

manner that the action of the hand on the handle of an umbrella, when opening it horizontally, maintains the position and directs the movement of the umbrella. The ball therefore moves out from the bore, following the axis of the barrel, without any movement of rotation" [in the direction of its motion].

There is so much want of real practical knowledge displayed in the construction of this projectile and in the *fanciful* description of its movements, that we cannot be much surprised when we learn that the report adds, that, "the flattening of the anterior part of this bullet, and its small volume, cause it to have but a short range, so that its accuracy and penetration disappear entirely at about the distance of 500 metres," or 540 yards, a result which all who understand the subject will say is contemptible indeed. And yet it was considered to have advantages over those in use, so far as to induce the French authorities to adopt it for the time being, and give it to some of the troops which were engaged in the Crimean War.

In consequence however of the mixed use of such inventions as Captain Minié's, the solid *tige* bullet, and Captain Nesler's, together with the barbarous method of grooving the barrel, which the French had adopted, matters were in so unsatisfactory a state, so late even as the beginning of last summer, that the French Minister of War found it necessary to charge a special Commission with the task of constructing a bullet of a better description, issuing at the same time a programme specifying the conditions which were to be complied with in forming the new projectile.

After a great number of experiments with different forms, and without taking into account too exclusively the conditions of the programme, which the Commissioners found it was impossible to satisfy, they determined on the bullet represented by Fig. 7; the length being ·845 inch.

According to the Commissioners' report, "the hollow of this projectile is composed of a part being a triangular pyramid, reposing on a circular bevilled edge, with which the faces of the pyramid are made to accord by the faces being cut. The entire depth of the hollow is about ·551 inch. The *form* of the hollow is made in this manner. In a circumference of ·677 inch diameter, representing the cylinder of the projectile, two concentric circumferences are drawn, one of ·598 inch diameter, and the other of ·484 inch. An equilateral triangle is inscribed in the second, and the parts of that triangle cut by the third are the bases of the faces of the pyramid and the origin of the cut sides of the bevilled edge. The salient angles of the pyramid are put out by the cut sides, which have, for bases, the small parts of the third circumference, intercepted by the sides of the triangle." Letter A represents the side, and B the end, of this projectile.

There is something so painfully ludicrous in the description of the hollow of this bullet, that it is difficult to believe that any man, who thoroughly understood the real character of the explosion of gunpowder, and the nature of a soft piece of lead, would sit down quietly, and attempt seriously, to

construct such a useless form. Did the inventor for a moment consider what the state of that form would be, on the explosion taking place? No; it is impossible, and the result shows it; for the report made to the Minister of War tells us, that "the accuracy of these projectiles, though tolerably good, is yet very inferior to the "Minié" ball (which is bad enough), and that their only advantage over it is in their being somewhat lighter; weighing only one ounce and a quarter.

We may learn, however, a great deal from the Report of the French Commissioners; but it is to avoid the faults which they have committed, and to beware of the erroneous deductions which they have drawn from their experiments. Their inventions afford us not one single idea which is worthy of imitation; indeed it would be no difficult task to upset entirely the whole of the conclusions they have come to. Until they banish from their minds completely the erroneous theories of Captain Delvigne and Captain Minié, on the subject of expansion, they will never succeed in constructing a superior projectile, *unless by mere accident.* Experience should have taught both them and the Americans that the projectile and the manner of grooving the barrel are so closely allied, and so dependant on one another, that it is worse than vain to attempt to try the merits of one if the other be defective: as well might the engineer attempt to try the qualifications of a new engine, with a worn-out or defective piston.

For close combat, it may matter little what the

form of the projectile may be; but for long and accurate ranges, the French are, at the present day, very far behind, both in projectiles and in the mode of grooving the barrel. This part of the subject, however, belongs more particularly to my next Lecture, and will be alluded to in it somewhat fully.

The experiments to which I have already alluded, have clearly shown that neither "cups" nor "plugs" do the duty which their inventors have assigned to them. So far from being driven in, as they are generally supposed to be, a great majority of the cups are either canted on one side, or *squeezed* out altogether, by the contraction of the cavity. Such as do remain, and do not cant, are found in their original position, held firmly by the contraction (or, more correctly, the *inward* expansion) of the lead; for if the cups were picked out, it would be seen that the part of the cavity beyond where the cup sat is pressed inwards, as represented by Fig. 8. From the peculiar shape of the wood plugs—which is that of a frustum of a cone, made to fit a portion of the cavity next the base of the bullet—they are not so liable to be upset, and held in a canted position; but they are very often squeezed out altogether, like the iron cups. I have found, on different occasions, as many as two-thirds thus thrown out, but have never yet seen one that was *fairly* driven in.

Indeed, it may appear somewhat paradoxical; but, though strange, it is no less true, that the success of the "Minié" system is entirely owing to the *practice* being in direct opposition to the *theory*. Theory tells

us that the cup or plug is driven in. Practice replies that it is no such thing; and practice is, in this case, the soldier's friend. If the plugs and cavities were so constructed—that is, if they were made a little more cylindrical in form—so as to permit of the plugs being actually driven in by the force of the explosion, the most frightful consequences would be the result; for the cup or plug would not stop at the bottom of the cavity, and *there* resist the powerful agent which drove it thither, but the fore part of the bullet—plug and all—would often give way, and be carried off by the tremendous force of the gases, leaving the cylindrical portion of the bullet sticking fast in the barrel, and the soldier helplessly exposed to the enemy's fire, without his being able to load and fire another shot. It is, indeed, fortunate for him that the "Minié" system *is* a fallacy; for were it otherwise, nothing but disaster would attend our arms. This is no mere theory, but a fact, which is supported by the strongest evidence, which the want of time alone prevents my now placing fully before you.

The Americans, in the course of their experiments, tried a bullet with a conical cavity, and a plug made of lead and tin, not unlike Mr. Greener's. According to their report, "the plug answered the purpose, and the firing at 200 yards was very good; but the plug fell out after a short flight, and consequently it might do injury," as they justly remarked, "to their own men." Here is another proof of the truth of what I have already stated, with regard to cups and plugs falling out; though the Americans do not appear to

have traced the result to its true cause. The plug does not leave the bullet after a short flight, but being a hard metal of a conical form, it is loosened by the contraction of the cavity, and *follows* the bullet to a limited distance, according to its weight; in this case, it seems, to nearly 200 yards. A *solid* plug made of lead and tin will, of course, follow the bullet to a greater distance than an iron cup, or a wooden plug, though *they* also are loosened in the barrel, in the same manner.

If it were not for this irregularity and uncertainty, the wood plug bullets would not only make better practice than those with iron cups, but they would make very superior shooting. If, therefore, those who will still persist in using them could only be induced to treat their "expanding" agency as a gross absurdity, and alter their shape so as to retain them as firmly as possible in their *original* position, they would find that more regular practice would be the result.

I attempted to remedy this *separating* evil by getting a number of plugs made, the same as those now in use in the British army, with this exception, that the *edges*, for about one-sixteenth of an inch, were made cylindrical. The edges of the cavity in the bullets were also made cylindrical; so that the one fitted firmly into the other as represented by Fig. 9. The result of this alteration was, that the plugs kept their places better, and made more regular shooting; but still, from the conical shape of the front part, some of them were squeezed out by

the contraction of the lead. The trouble and expense of their manufacture were also great drawbacks, and hence the contrivance of what I have called a "disc" bullet; the cost of the discs being only about a fourth or fifth of that of cups and plugs; and very simple in their application. This bullet is represented by Fig. 10.

In the end of the bullet, which is a fair cylinder for half its length, I have a cavity formed as shown at A, which extends a little more than half the length of the bullet. Upon the edge of the cavity B B, I place the round disc C, which is cut out of thin iron to fit exactly. When the explosion takes place, the disc becomes so firmly fixed by the contraction of the lead around it that it never falls out, nor is it driven, *or intended to be driven,* further in than the rest of the lead at the base of the bullet.

Experiments show, that the "disc" bullet rifles itself as distinctly as if it had been cast in the grooves of the barrel: a complete answer to the *supposed* effects of all "expanding agents." It may also be called a *safe* bullet, for any number may be fired at a distant object over the heads of bodies of men employed or moving in the intermediate space, without any fear, as the Americans had, of the discs leaving the bullets and injuring the men.

I have fired thousands of these bullets, and, though not a first-rate marksman, I have repeatedly placed 70 per cent. of them in a space the size of a man, at 600 yards. This can be corroborated by the most unquestionable evidence.

For deer-stalking, this bullet would be invaluable, if accompanied by a mode of grooving the barrel, which I shall describe in my next lecture; for, besides its accuracy and certainty, it has a very low trajectory, and a low trajectory is always a sure sign of great velocity. A bullet fired horizontally falls to the ground in a certain portion of time; this is an incontrovertible law of nature—the law of gravitation or attraction. A bullet, therefore, that flies with more velocity than another, will attain a greater range before it is drawn to the ground by the force of gravity. This greater range, with the same elevation, it is well known to those deer-stalkers whom I have the honour of addressing, is often of the utmost consequence, for they find themselves frequently in a position to make a deadly shot, if their rifles would but carry 40 or 50 yards further, with the same sight. A greater elevation, in such a case, would only subject the deer-stalker to greater uncertainty.

Having satisfied many of the best rifle-shots in the army of the superiority of these bullets over the "Minié," I applied to General Sir J. Yorke Scarlett, under whom I have had the honour of serving, and he kindly obtained for me an order from His Royal Highness the General Commanding in Chief for some of them to be tried with the Service ones.

To Aldershott I sent a quantity; and the report I received in return stated, that "the shooting with them was much superior to that which was made with the Service ammunition—the officers of the

Rifles expressing a wish that they had some millions to take with them to India."

Another report stated, that "the shooting was splendid, and that nothing they had could by any possible means beat it."

To Hythe I also sent a number of rounds, which were tried; and, with reference to some of Hall and Sons' powder, which I had also sent, the report states, that "trials were then made with the Regulation powder, the result of which prove, as far as they have gone, that although there appears little difference in the shooting of the two descriptions of bullets," namely, mine and those of the Regulation pattern, "the loading with the latter is easier than that with the former — the former being found to be two thousandths of an inch larger in diameter than the Regulation bullets."

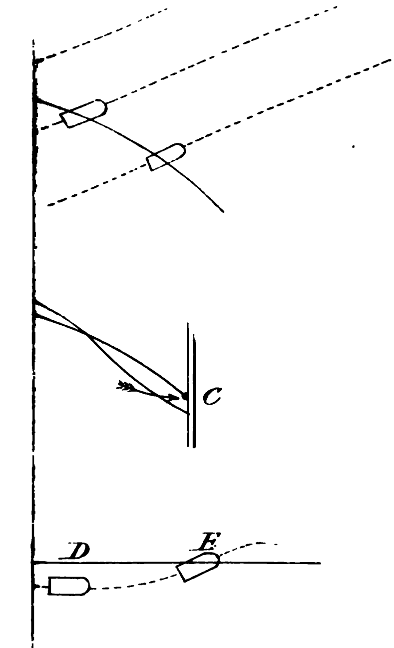
This is another report, which is clearly in my favour; for even if everything else were equal, a bullet two thousandths of an inch too large in diameter, would, as a mere matter of course, not only be more difficult to load, but it would, in many cases, have the paper partially or wholly dragged off by the extra friction in the act of loading, leaving the bullet in a worse condition than if no greased paper had been used at all.

My bullets were *cast* in a mould, and merely swaged. The Regulation ones were *compressed* by machinery—a great desideratum to the expert rifleman; for compressed bullets are always *denser*, and of a more homogeneous texture, and are therefore less

liable to be blown out of shape, or even blown *to* pieces, as "cast" bullets often are. With regard to the difference in the size of the Hythe ones, I may state, that I passed them through a gauge I had from the Ordnance Department, and therefore took it for granted they were correct; it is, therefore, very probable that too *thick* a paper must have been wrapped round them. With all these disadvantages, however, it will be seen, that the Hythe authorities admit that my bullets were equal to the Regulation pattern. What the comparative practice might have been, if carried out to a greater extent, and on really equitable terms, by having a thousand or more made by machinery at Woolwich, and assorted and prepared as carefully as the Service ones are, I leave others, who can judge, to determine.

I have here attempted to give an abridged history of the rise and progress of the "Minié expansion" system, and to remark on those principles which, in my opinion, are sure to supersede it. I have laboured for years to expose the falsity of the system, and it is now pleasing to think that its practice will soon be at an end. In America it has been tried, and formally condemned. On the greater part of the Continent it has met with the same fate. In France itself, where the system, as at present understood, may be said to have had its origin, it has given way to other plans. In England, the wood plugs, which have hitherto been called "expanding agents," are now (I have been informed by a member of the Small Arms Committee) believed to be only useful in preventing the sides of the

bullet from collapsing; so that this great and popular delusion, which has made so much stir in the military world, may be said to be virtually at an end. It must, therefore, be gratifying to all who would encourage the growth of true principles, that this blot on our science of gunnery will at last be removed; for truth is all powerful, and must ultimately prevail over every cavil and every objection.



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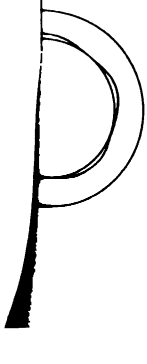


LECTURE II.

VICE-ADMIRAL
HIS GRACE THE DUKE OF NORTHUMBERLAND, K.G.,
&c. &c. &c.,
IN THE CHAIR.

ON THE COMPARATIVE MERITS OF THE RIFLED SMALL ARMS OF ENGLAND, FRANCE, AND THE UNITED STATES; WITH REMARKS ON THE VARIOUS MODES OF GROOVING RIFLE BARRELS.

The interest which my last Lecture must have created, if I may judge from the numerous communications I have received, makes it a duty incumbent on me to offer some explanation why my projectile, which has been so successful under different trials, has not been adopted, or even countenanced, by the English Authorities.

Having satisfied some of the first rifle-shots in the army of the superiority of my bullets over the "Minié," I, with every confidence, applied for and obtained an order from the Ordnance Department to have them tested at Enfield, to which place I forwarded six bullets with and six without discs, as specimens, to be laid before the Small Arms

Committee. I waited then patiently, expecting every week to receive an order for a sufficient supply, and to attend certain trials to be made with them. Six months thus passed away however without my receiving a single word from Enfield, when at last I received what I had long looked for—a letter; but to my great astonishment, instead of an order to attend a series of trials, it contained a copy of a report from the Committee, which, by the kindness of the Secretary of State for War, I am now permitted to use.

"I have," says the writer, "to inform you, that the Committee, having examined the diagrams of comparative practice made at Enfield, between your disc bullet and the bullet now adopted in the Service, find that in accuracy the Service bullet has rather the advantage; and that, as they do not see that your bullet has any advantages over the Service one, so far as its manufacture is concerned, they do not consider it necessary that any further experiments should be made with it.

(Signed) "H. R. Drewry."

It may easily be supposed that I was utterly at a loss to know what to make of such a report; as I had sent no bullets for trial, nor had I even been asked for any. The most charitable construction which I could put upon such a strange proceeding was, to suppose that some imitations of my projectile had been made, by *casting* them in a mould; for none, I ascertained, had been made at Woolwich by machinery. Supposing then that such had been the case, any man, sufficiently conversant with the

subject, must know, that *apparent* trifles make in the aggregate the efficiency of the projectile, and that, unless it is made *in all its proportions*, strictly in accordance with the ideas of the inventor, it cannot be expected to have the desired effect. Suspecting, then, that inattention to some important but overlooked points must have been the cause of the inferior practice, I applied for a few of the same sort of bullets with which the diagrams had been made, for the purpose of examination, and received the following in reply: "With reference to your request for a few of the bullets made use of in the experiments reported on the 17th June, I am to inform you that it cannot be conveniently complied with.

(Signed) "JOHN CROOMES."

What was I to think of this? Here was a report sent in to the Secretary of State for War, condemning my projectile; and yet I was not permitted to have the poor satisfaction of even looking at one of the same sort, which the Committee had been pleased to call mine! I knew that I had sent them none for trial. I knew that none had been made by machinery, like the Service bullets. If they were cast, then, were they *swaged?* Were they made *cylindrical?* Were they even like mine at all? I, the most interested person, can answer none of these questions!

For many years I have carried on expensive and laborious experiments, and have never asked the British authorities for any assistance whatever. All I asked was, that the results of my labour might have a fair test. I had the sanction of the Chief of

the War Department for this purpose, and a *fair* trial was no doubt meant by his Lordship; and a fair trial such a report must have led him to believe that I had.

A few weeks ago a letter appeared in the *Times*, written by an Officer of the Enfield Factory, in which he says, in reply to another correspondent, that "all Governments are slow in adopting improvements, as they cost money, and it is desirable to be sure that that money is rightly spent." To such a remark the most self-satisfied inventor could have no objections; but, in my case, I was offering not only an *improvement*, but one which would have also saved a large amount of money.

As regards expense, I had represented to the War Department that the cost of the discs would not be above a third of that of either cups or plugs. The Enfield Committee, it will be seen, deny this, for they say that "they do not see that my bullet has any advantages over the Service one, *so far as its manufacture is concerned.*" As one or other of these reports must be wrong, let me beg attention to the following simple facts:—

The iron cups may be made for 2*s.* 6*d.* per thousand, though as much as 2*s.* 9*d.* has been paid for some of them. The wood plugs may be made for less, nominally speaking; but, as great waste attends their manufacture, their cost may be considered, in reality, to be higher. The discs are a very simple form, and may be cut by a machine with great rapidity. Machinists, in London and Birmingham,

have assured me that they will undertake to supply the Government with any quantity, at 6*d.* per thousand; or make a machine for £200, which will cut 1,000 discs per minute, or 500,000 per day—a greater number than all the plug machines at Woolwich put together, with their attendants, can now turn out in the same time.

Since I first brought my bullet into notice, about 300 millions of cup and plug bullets have been made. This number, taken at 2*s.* 6*d.* per thousand, amounts to £37,500. An equal number of discs, at 6*d.* per thousand, amounts only to £7,500; so that a saving of £30,000 might have been effected during this period, independent of the cost of all the plug machines, for they were constructed and set up *after* my bullet had been introduced to the notice of the Enfield authorities.

The number manufactured at present is about a million and a half weekly, which, at 2*s.* 6*d.* per thousand, makes £187. 10*s.* The same number of discs would cost only £37. 10*s.*; so that £150 per week, or £7,700 per annum, might even now be saved; and yet the Committee say that "there would be no advantages (in apopting my plan) so far as the *manufacture* is concerned!"

I offer this short explanation, in answer to those gentlemen who have so kindly taken an interest in the matter; but I add no comments of my own, feeling assured that a simple statement of the facts is best suited to enable others to form an unbiassed opinion on the subject.

A bullet may be regarded as a reservoir of force or motion, always ready to return as much as it has received. The quantity of its motion, measured by its velocity and *quantity of matter*, is also the measure of the degree and direction of the force or forces which produced it, and of the force or momentum which the bullet can exhibit again when opposed or made to act itself as a cause. The *force* of a bullet's motion is, therefore, precisely equivalent to the force expended in producing it. It is as if a *transfer* of the principle of force were made from the gunpowder or moving power into the bullet or body moved, as the bullet will be ready to *reproduce the whole of the force*, and to cause it to operate on the *obstacles* which it encounters.

The first obstacle which a leaden bullet has to contend with is, the *inertia* of some of its own parts; then the *friction* or rubbing of its sides on the sides of the barrel; the *condensed air* in front of it in the barrel; and then, again, the *resistance* and *friction* of the air and *gravity* outside the barrel. These obstacles are all more or less increased or diminished by the *peculiar shape* and *length* of the bullet; but all being causes of *retardation*, they will continually destroy a portion, more or less, of that force of motion in the bullet, which was nevertheless, *originally*, precisely equal to the force expended by the powder in putting it in motion.

A long bullet has a more considerable mass or quantity of matter than a short one of the same thickness, and therefore the losses of velocity will be less

with the former than the latter; and, in consequence, the longer bullet may leave the muzzle with a less velocity than the shorter one, and still acquire a superiority over the latter at a very short distance. But this observation must not be applied, as a general rule, to bullets of *any length*, or it will lead to very grave errors; as the degree of spiral, the quantity of powder, and the peculiar motion of the bullet in the air, affect the velocity of some bullets in a manner apparently not generally understood, if we may judge from the strange theories which have been adopted by some writers on the subject.

In France, a theory of the motion of a bullet in passing through the air has been framed, which, like the "Minié" system, has been freely adopted by English writers, but, apparently, as a mere matter of course. We are told by the French authorities, that "elongated projectiles, whose centre of gravity does not exactly coincide with the centre of figure when they do not turn over, tend to preserve their axis in the line of fire or *primary* direction which is imparted to them." According to this theory, Fig. 1, in the diagrams, shows the position of a bullet having its centre of gravity in the hind part.

According to such a theory, no bullet having its centre of gravity behind the centre of its figure would ever hit the target point foremost, unless at very short ranges. We know this, however, to be quite a mistaken notion, if a *sufficiency* of rotatory motion be given to the projectile.

Another theory, of a somewhat singular character,

has found its way into the "INSTRUCTIONS OF MUSKETRY," issued for the use of the British army: a copy of the diagram is given at Fig. 2. "The best way of describing," says the writer, "the motions of a rifled projectile in its passage through the air, is by means of a bent arrow (B). Suppose the arrow was shot from the point A, with a view to hit the mark C; if the bent point of the arrow were placed upwards, and no spinning motion given to it, the greater pressure of the air on its convex side would tend to send it in the direction D; but if it had previously received a spinning motion, by the time it reached E the point would have turned in an opposite direction, and therefore it would proceed downwards, *crossing the true* trajectory, and proceeding *as far beneath it* as it had at first *risen above it:* thus it would continue, throughout its course, to move in a spiral direction *round* the true trajectory, constantly correcting the error due to its imperfect figure; and, ultimately, it would strike the mark much nearer than if it had received no spinning motion."

An officer of the Bengal artillery also favours us with his ideas of the motions of a rifle bullet in its passage through the air. His theory is not unlike the last, and his diagram is shown by Fig. 3. "The diagram," says the author, "is supposed to represent a vertical section of the flight of a spiralling bullet. Now, suppose the projectile to leave the rifle, and to be spiralling to the right hand; the air will then instantly assign to it a position, with reference to the line of fire, similar to the one seen at A. By reason

of this position, the effect of the condensed air will be to drive the bullet upwards, away from the line. As the bullet turns on its axis, however, that effect will ever be changing; and, by the time a quarter of a revolution has been effected, a quarter of a spiral thread — round an imaginary cylinder — will have been described by the bullet, which now occupies the position marked B. Another quarter of a revolution will give to the bullet the position marked C; and, afterwards, the third and fourth quarter revolutions, marked D and E, will bring the bullet back as great a distance to the left as the second and third influenced it to diverge to the right."

There is, surely, much want of real practical knowledge displayed in the conception of all these theories. With reference to the two last, however, a careful study of the laws of gravitation would have shown that it is contrary to the laws of nature for a leaden projectile to fall *and rise again*, while passing through the air, unless it be affected by some external force.

In any mass of matter, however irregular may be its form, there are at least three lines round which its parts are so arranged that, if it be made to revolve upon either of them as an axis, the centrifugal forces are so balanced as to exert no strain upon the axis, and, consequently, to have no tendency to alter its position. These three axes, which are called the *principal axes*, are at right angles to each other. Their length will be different in almost every instance; and this difference produces an important

influence on their respective properties. When they are all of the same length, the body will rotate equally well on either of them; this is the case, for instance, in a globe, the number of whose principal axes has no limit. But in a body, like an elongated bullet, whose principal axes are unequal in length, it will rotate *securely* on the *shortest* of these axes only; that is, if, whilst rotating upon its *longest* axis, it be slightly thrown out of its position, it will have no tendency to recover itself, but will alter its condition altogether, and will revolve round its shortest axis. For the same reason, if, whilst rotating around the *shortest* axis, it received any disturbance, it will not now change to any other axis, but will recover itself, and thus constantly tend to maintain its position round its shortest axis.

This principle may be familiarly illustrated by a simple experiment made upon an ordinary seashore pebble. Let us suppose this to be of a regular oval form, having two surfaces somewhat rounded. The three principal axes of such a pebble will be—1. The long diameter of the oval side, or the line joining its two furthest points; 2. The short diameter of the oval side, or the line joining its two nearest points; 3. The line joining the centres of the two sides, thus crossing the thickness of the pebble. Now we can spin such a pebble upon one of its ends—that is, around its long diameter—as an axis; but it will be very unsteady, and that in proportion as the force applied is less; and the slightest variation of its position will overturn it altogether. The same will

occur when it it is spun upon the side edge; that is, around its short diameter. But when it is spun upon one of its rounded surfaces, it has no tendency to fall over, since it is then revolving around its *shortest* diameter; and if disturbed, it will return to the same position. Hence the axis around which a body of any form is in rotation will always tend to change into the direction of its shortest principal axis, and will then remain settled.

This experiment may not be regarded as fully illustrating the principle; since, when the axis is supported from below, the tendency of the centre of gravity towards the lowest possible point will naturally cause the body to assume that position. But the same thing happens when the change of the direction of the axis is such as to leave the centre of gravity where it was; and it will even take place when it cannot occur without raising the centre of gravity. Thus, let a body be suspended, hanging by a string, freely from any point which is not the extremity of its shortest principal axis of rotation. Now, if we make the body revolve with sufficient rapidity, it will not rotate around the axis in which it was hanging, but about its shortest axis, which is the line that crosses its thickness, through its centre; and it will do this with so great a force (if the motion be sufficiently rapid) as to overcome the weight of the body which tends to keep it in its first vertical position, so that it will gradually lift itself up, bringing its rotation continually nearer to its shortest principal axis; until it will (so far as the eye can

perceive) find that axis, and will rotate about it: its centre of gravity thus becoming as high as the point of suspension.

A very simple machine may be constructed from the sketch Fig. 4, which will clearly explain this rotation.

Upon the stand A B is fixed the pillar C, carrying a horizontal arm D; at E there is a small pulley, turned by the multiplying wheel F, which is moved by the handle near its circumference. To the pulley E a string is attached, to which bodies of various forms may be suspended, from any other axes than their shortest permanent axes. On turning the wheel, the body will not rotate about the axis G H, but will alter its position, continually approaching to a rotation about its shortest principal axis, as represented at I; raising, as I have already stated, its centre of gravity as high as the point of suspension.

In the progress of this change, a remarkable optical phenomenon presents itself. The body beginning to revolve obliquely, the place to which each part of it returns, after the interval of a revolution, is, in the intermediate time, left vacant; so that the sensation of vision is from that place removed, not continuously, but impulsively. So rapid, however, are the impulses, that one sensation remains until it is replaced by the next; and the body appears at one and the same time to fill the whole space, whose parts it in reality occupies in succession—a phenomenon analogous to that of the continuous circle of flame shown by a fire-brand which is whirled rapidly round.

It is thus, no doubt, that many men are deceived by the eye, with regard to the actual motions of large elongated shot or shells, when trying to observe their motions while passing through the air.

The reason of this curious property is easily explained when the principles of centrifugal force are understood. When a body is revolving round its *longest* axis, the parts composing its mass are disposed in such a manner as to be at the *least* possible distance from the axis. On the other hand, when it is rotating about its *shortest* diameter, the parts are so arranged as to be at the *greatest* possible distance from the axis. Now it is a property of centrifugal force, that it causes the parts of a revolving body to dispose themselves at the *greatest* possible distance from the centre; and this will be the case, therefore, when the rotation is round the *shortest* axis.

These principles being thoroughly understood, there will be no difficulty in applying them practically to the motion of projectiles of any given length. Long bullets never range *far* correctly, unless fired out of barrels having very rapid deep spirals, with a corresponding rapid propelling force, to counteract the greater tendency which such bullets have to rotate round their shortest axis. This is exemplified in England, in Mr. Whitworth's hexagonal rifle. His bullets are 3 calibres in length; but the twist of the grooves is *rapid* in proportion, being 1 turn in 20 inches, and very deep, with *heavy* charges of powder, considering the calibre of the barrel, which is not half an inch, including even the depth of the grooves; for

the hexagonal *angles* are merely grooves in disguise, and, moreover, very objectionable grooves in shape, as may be seen by referring to Fig. 5, which is drawn on a larger scale for the sake of distinctness—the inner circle representing the end of a bullet, so as to distinguish the depth and shape of the grooves more clearly.

Colonel Jacob's bullets were also, at one time, made very long, with a rapid spiral, deep grooves, and heavy charges; but he has lately made a change to something approaching moderation, compared with what he had adopted formerly, having found that his former system was radically wrong. His bullets are still, however, as long as 2½ calibres, with a deep spiral of 1 turn in 3 feet. In France, long bullets have also been tried, and found to require a very rapid spiral. All these bullets may be said to be *solid*, having their centres of gravity in the hind part; for Mr. Whitworth's bullet, though it has a slight hollow in its base, would be better to have none; as no cavity of any depth could withstand the shock of the explosion of such charges, resisted as the bullets must be by the enormous friction which a *long* bullet and *deep* grooves create.

It is reported, that "Mr. Whitworth discovered in the course of his experiments, that according to the quickness of the turn in the polygon (or grooves), is the length of the projectile that may be fired." In order to teach the principles of elongated projectiles and rifling correctly, Mr. Whitworth should have reversed his observation, by saying that "the longer

the bullet intended to be used, the more rapid the turn or twist of the grooves should be made." Had he been compelled to adopt the same large calibre as the Enfield rifle, his practice lately, compared with that weapon, would have told a very different tale.

If a long bullet were fired out of a barrel having a *slow* spiral, the result would be, that ere it ranged to any considerable distance its rotatory powers would be gone. But why? That *point* which constitutes the centre of *gravity* in any bullet is also the centre of *inertia*, and, although not in every instance, it is, in this case, also the centre of *motion*; and is, therefore, the point in any projectile which *traces* the line called the trajectory. This point, then, in flying through the air, instead of rising and falling, as represented in the Diagrams Nos. 2 and 3, will pass steadily on, describing the trajectory, while *both* ends of the longest axis of the bullet, which passes through this point, will trace a spiral circle round the trajectory, if the motion of rotation be comparatively slow; but this circle will be *closer* to that line as the motion of rotation is made more rapid. If the motion of rotation, however, has been made *sufficiently* rapid, the spinning of the axis will then be *motionless*, and will form, as it were, a perfect *tangent* to the curve.

This is the *only* position which a bullet can be made to adopt that will enable it to pass through the air with the least retarding and deviating influences acting on it; and it can only be made to adopt this most favourable position by bringing to its aid *a happy combination of excellences*—such as the most

suitable calibre and length of barrel; the number, form, and twist of the grooves; the quality and quantity of the powder; and the shape, length, and fitting of the projectile itself. If these are not in harmony the one with the other, like the parts of a complicated machine, a very high degree of excellence in practice will never be the result. One defective link in the whole, though of apparently little consequence, if overlooked or neglected, will derange the working of the others if ever so carefully studied. This should teach the gunmaker that it is vain to attempt to make a rifle on a superior plan if he does not, at the same time, study the nature and shape of the projectile which he intends should be used with it.

With a *slow* spiral the motion of rotation will be rendered still slower, in consequence of the additional friction which a long bullet sustains in passing through the barrel; the ends of the bullet will, therefore, from its great length and tendency to return to its shortest axis, trace a more open circle round the line of the trajectory, offering a great surface to the resistance of the air and the deviating powers to act upon; and these circles, by the continual resistance of the air, will become more and more open—or, in other words, the bullet's original force of rotation round its longest axis will rapidly decrease, and, after adopting a number of spontaneous axes, it will finally settle in the shortest axis which can be obtained, and this is the most unfavourable position for long and accurate ranges.

This sort of motion is very distinctly perceived

in the common spinning-top. If of homogeneous material and symmetrical form, it will revolve steadily in the same position until the friction of its point with the surface on which it rests affects its motionless appearance: it will then begin, as it were, to acquire life—opening out its top centre with a circular spiral motion more and more, its point doing the same; then rotating unsteadily, until at last it falls on its side, upon which it will continue to rotate until friction and the resistance of the air stopped it if it were made of an egg-like or oval form.

Here, then, we have an explanation of the real motion of an elongated bullet while passing through the air, and why very long bullets require a more than ordinary rapid spiral, and, as a matter of course, a great propelling force to drive them through the barrel. But no *real* benefit can accrue from such extreme practices, as the bullets, being heavier, are more expensive; they require more powder to give them the necessary degree of velocity; the recoil, caused by the resistance in passing through the barrel, is augmented, taking away from the effects of the charge, great as it is, and deranging the aim of the marksman; and, further, very long bullets add unnecessarily to the weight which the soldier has to carry.

These remarks apply only to very long bullets, compared with those of medium length; as some of the latest French bullets (as Captain Nesler's, for instance,) approach so near to the other extreme that they are really not so much as one calibre in length.

In such cases the axis of rotation is not at all liable to be disturbed, as the bullet, being shorter than the calibre of the barrel, will rotate round its *shortest* axis from the very commencement, and it may therefore be fired with advantage from a barrel having a very slight inclination of spiral, compared with that required for longer bullets; but the range will be much less, for this simple reason, that such a bullet as Captain Nesler's cannot have within itself the same *quantity* of force or momentum. The bullet that was constructed by the last French Commission is certainly somewhat longer than Captain Nesler's; but in consequence of its having a large cavity, and a deep gorge round its middle, the *weight* is not much greater than his, namely, about 500 grains, and this for a seven-tenths (·700) of an inch calibre!

It is difficult to understand why the French authorities should now countenance such very short bullets, considering the large size of the bore; for during a course of experiments which they carried on a short time ago (though certainly with very inefficient weapons for experimental purposes), it was found that bullets upwards of two calibres in length could be fired with great precision. The great weight the soldier would have to carry, I believe, is the only cause for such an unscientific mode of proceeding.

The Sardinian authorities have lately announced their intention of giving premiums for "the best musket for infantry and riflemen, and for approved inventions connected therewith." Now a rifle or a rifle-musket may be made on the most approved

method, so far as the lock, stock, and their accessories are concerned; but unless the projectile itself, and the mode of grooving the barrel, be strictly scientific and of a superior order, the mere workmanship of the most skilful mechanic can be of no avail.

In determining on the best weapon for the infantry and riflemen of the Sardinian or any other army, I think it is desirable, in the first place, to ascertain what *number* of rounds of ammunition the soldier should carry, and then to see by what means that number may be reduced in weight for the comfort of the soldier and the easy transportation of sufficient supplies, and still be made available, in the highest degree, for the benefit of the service.

Taking it then for granted that the English authorities had good reasons for fixing on 60 rounds, 530 grains each bullet, as the proper number and weight for a soldier to carry, was it advisable to make the calibre of the barrel so large as ·577 inch? I venture to think that it was not. Yet it must be admitted that the English Commission made a bold step, in the right direction, when they reduced the calibre from ·702 to ·577 inch; more especially when we take into consideration the great opposition the Commission had to contend with in reducing the calibre even so far. In America, however, they have as certainly taken a step in the wrong direction, by increasing the calibre of their rifle from ·540 to ·580 inch. In France, where the authorities retain their large calibres, they are unquestionably far behind in the march of improvement, as large calibres are not

adapted for propelling elongated bullets, of a moderate weight, combined with the *best* proportions. It is true that in France there are one or two arms having a very small calibre; but there, again, they jump to the opposite extreme.

In constructing a bullet of good proportions, it should be carefully borne in mind that it is not the *size* and *shape* of the projectile *before* it is placed in the barrel, but what these may be *on its leaving the muzzle*, which constitutes its effectiveness. The English bullet is ·960 inch in length; ·568 inch in diameter; windage for paper, &c., ·009 inch; depth of grooves, ·014 inch; so that, on leaving the muzzle, it will be expanded to ·581 inch in thickness, and shortened to about $\frac{3}{4}$ths of an inch in length. The American bullet is 1·050 inch in length; ·577 inch in diameter; windage (no paper being used), ·003 inch; depth of grooves, at the muzzle, ·005 inch; so that it would leave the muzzle expanded to ·585 inch, and shortened to about $\frac{7}{8}$ths of an inch. The French bullets—for it is impossible to select one as the representative of the whole—will generally leave the muzzle expanded to ·705 and ·720 inch, including the depth of the grooves; but some of them will not be even so much as that in length! The result of all this is, that none of these bullets will leave the muzzle of the rifle, possessed of the *best* proportions, for long ranges, considering their weight.

With elongated leaden projectiles there are always certain proportions which will be found to have the

best results—the calibre and grooving of the barrel, and the proper quantity of powder, being taken into account—and experiments alone can determine what these proportions ought to be. Now, as the average weight of the English, French, and American bullets is about 510 grains, a much more effective bullet than any of them—both for range and penetration—may be constructed, by reducing the calibre of the barrel to exactly half an inch (·500 inch), *including* the depth of the grooves; the bullet being made say 1·100 inch in length, so as to leave the muzzle about two calibres in length, and not weigh more than from 500 to 520 grains. By increasing the length of the bullet beyond this point, the initial velocity which is obtained, in consequence of the friction, is insufficient for it to acquire momentum and rotatory motion enough for very long ranges, without resorting to extreme spirals and heavy charges; and these would only destroy the proper shape of the bullet. On the other hand, by reducing the length within this point, the effect would be equally bad, as the momentum would not be sufficient, owing to the lightness of the bullet. So that, by increasing or diminishing the length, no real advantage is gained, but the contrary.

Rifles with a half-inch calibre offer very notable advantages; as they can have a greater degree of thickness of barrel, without increasing the weight. The charge of powder can also be reduced without reducing its efficiency, if the spiral is not made too rapid. This naturally leads us to the consideration

of that all important subject, namely, the best mode of GROOVING THE BARREL.

It is assumed by some that a very high rotatory velocity should be given to the bullet, in the first instance, in order to ensure a continuance of the rotation to the end of a long range. There is, however, little foundation for such an assumption, *unless the bullet be very faulty in form.* Indeed, the velocity of the onward movement decreases much more rapidly than the rotatory motion, as the former creates *great resistance,* while the latter has only the *simple friction* of the air to contend with. A peg-top, for instance, will continue to spin upon its point for one or two minutes; then, surely, a cylindrical bullet, whose form and density are much more perfect, if its shape is not destroyed in the barrel, will continue its rotatory motion for as great, if not a greater, length of time, and not stop, as some suppose, at the end of one or two seconds. If, therefore, a sufficient velocity of rotation be given to the bullet to keep its axis a perfectly true tangent to the curve *during the whole period* of its extreme flight, every contingency is provided against, but every revolution beyond that will be productive of evil.

The spinning of the bullet in the air, at a very high velocity, may be considered a matter of very little consequence; but it is not always so, especially with bullets like Colonel Jacob's and Mr. Whitworth's, the one having square and the other having angular projections—for the more rapid their rotatory motion is made, the greater atmospheric resistance to that

motion is created, and the sooner, in proportion, will that motion be made to cease.

A great twist in the grooves of the barrel, to give a long bullet the high rotatory motion which it requires, is an evil of a most decided character—as the friction, and, consequently, the opposition to its passage out of the barrel, are very greatly increased, and the original shape of the bullet is, in many instances, nearly destroyed. With bullets formed like Colonel Jacob's and Mr. Whitworth's—with so much twist in the rifle as the former had at one time, and the latter has now—the *friction* must be enormous; for, even if made of hardened lead to resist the shock, the hinder end will be driven up on the fore part, to a certain extent, by the force of the gases, before the *inertia* of the fore part is completely overcome, and consequently the bullet will be wedged, as it were, by the pressure behind, more firmly into the grooves—causing a more than ordinary or necessary degree of friction, retardation, and, consequently, loss of velocity, before the bullet leaves the muzzle.

Colonel Jacob says, that "his bullet, having its centre of gravity in the hind part, is unsteady, and has a great tendency to fly with the wrong end first; and that, to counteract this perversity, a great twist in the grooves, giving a rapid spiral motion to the bullet in its flight, is absolutely necessary." This is very true; but why not improve the shape of the bullet, and reduce the twist of the grooves? A bullet having its centre of gravity in the hind part, requires a greater velocity of rotation to be given to it, in order to over-

come its inclination to rotate round its shortest axis; as its want of stability, arising from the resistance of the air in front, will be in proportion to the distance that its centre of gravity is behind the centre of its figure. In like manner, a bullet having its centre of gravity in the fore part will require less turn to keep it true, as its *natural* stability will be greater. In a report of the trials made with Mr. Whitworth's rifle, a melancholy amount of ignorance is displayed by the writer, "as giving an idea of *the extraordinary power* of Mr. Whitworth's rifle," namely, "that his projectiles, in their flight, rotate at the rate of 15,000 revolutions per minute." A *high* rotatory velocity, as I have already said, is absolutely necessary to counteract the tendency which a long bullet has to change its motion of rotation to its shortest axis, but it is absurd to say that a high velocity of rotation *adds* to its power. The fact is, it has quite a contrary effect.

That the motion of a body, when not retarded by the air or any other opposing causes, will continue for an indefinite period, there is the most satisfactory evidence, derived from those cases in which they are reduced to their smallest possible amount. Every reduction, then, in the amount of friction and of the air's resistance, is attended with a proportional increase in the continuance of the motion. We look at, and criticise, the form and construction of a bullet, *before* it is placed in the barrel; but it is evident, from the manner in which some barrels are grooved, that those who use them seldom think, when loading, that

they are placing the bullet in a *second* mould, where it will get *remoulded* before it again leaves the barrel. Let the barrel, then, be grooved in such a manner as will preserve the cylindrical part of the bullet as *smooth* as possible, and its motion, both progressive and rotatory, will be considerably prolonged.

It is much to be regretted that, under the head of "GROOVES," the American report is so indefinite, and the deductions which have been drawn by them are so inconsistent, generally, with the result of their experiments. "Of the 23 varieties of grooves tried in all," says the report, "that of gun No. 16 was found to give uniformly the best results with the altered muskets, while it was found to be fully equal to any for the new trial arms with smaller calibres. These grooves were the broadest and shallowest of any submitted to experiment. The general tendency of the results seems to confirm this conclusion, as it was found, in almost every instance, that the broader and shallower grooves gave the better practice, other things being equal." Yet, in the face of this, though it was found that the *broadest* and *shallowest* grooves gave the best practice, the Americans adopt a method commencing at the breech with a depth of ·015 inch, and ending at the muzzle with ·005 inch; because they say that "it gave less deviation and less 'drop' of the ball than a slope commencing at the breech with ·020 inch, and ending at the muzzle with ·005 inch." True; but who, that has studied this subject carefully and *consistently*, would ever think of making the grooves ·020 inch deep at the breech, or even ·015?

The French grooves were, at that time, ·020 inch deep at the breech; but that was no argument in favour of a bad system. The English grooves, at the present time, are ·014 inch deep, all through; but even that, I consider, is too deep for any beneficial purpose.

It is admitted by the Americans that the grooves of ·015 inch at the breech, decreasing gradually to ·005 at the muzzle, made the best shooting. Is it then not extraordinary, that, out of the 23 varieties of grooves tried, they never thought of trying a *uniform* depth of groove of a mean between the two, say an ·008 or a ·010 inch? No. The only uniform depths they tried *were in other things not equal*, the lands being in every case *broader* than the grooves—one of the greatest faults which a rifle barrel can have; and, moreover, a fault which is borne out and proved by the American experiments themselves.

"The effect of *depth*," says the report, "is best shown by comparing the results obtained with guns Nos. 7 and 12—the former having grooves about ·007 inch in depth, and the latter ·015 inch; in all other respects these grooves were alike." The grooves of both were uniform from breech to muzzle, and the lands were somewhat wider than the grooves; but the practice certainly told in favour of the *shallow* grooves.

"The effect of *breadth* on grooves," the report further says, "may be seen by comparing the practice made with guns Nos. 15 and 16. The grooves of these guns were alike in every particular, except in

width—those of No. 15 being narrower than No. 16." The practice here, again, was decidedly in favour of the *broad* grooves. Yet, with such results before them, the Americans seem to have had no idea of *increasing* the number of the grooves, by *reducing* the space taken up by *unnecessarily* broad lands!

A barrel rifled with a decreasing depth of groove from ·015 to ·005 would have its upper half at a depth from ·010 to ·005, just at the place where the full force of the powder and the greatest expansion of the bullet come into operation. This being the case, it is evident, from these experiments, as well as others which have come under my own immediate observation, that the improved shooting is entirely owing to the *shallowness* of the grooves *from the middle of the barrel upwards*, and not to the greater depth *near the breech*. But let us see if this can be proved beyond a doubt by any collateral evidence.

It has been proved by the nost scientific men, as I mentioned to you in my last Lecture, that all the parts of a charge of gunpowder are not ignited *simultaneously*, but successively; that, though it explodes so suddenly as to appear a simultaneous burst of flame, it is, correctly speaking, not so, but merely the rapid ignition and combustion of all the particles; and that a *portion of time* is necessarily occupied by the flame, however short that portion of time may be, in travelling from the first grain to the last. As the combustion proceeds, then, the powder is decomposed, and produces solid as well as gaseous bodies; but as the gaseous parts have a tendency to fill a much

larger space than that occupied by the powder before inflammation, they seek an outlet where there is *least* opposition; and *this outlet is the place occupied by the bullet.*

Now, experiments also prove that the bullet is *not* fully expanded *at the instant* it is moved from its state of rest; nor is the expansion complete until it has travelled up some portion of the barrel. Taking this *fact*, then, for granted, the first portions of the powder which are ignited will evolve a large volume of gas, which, from its tremendous elastic force, will increase the space it occupies, by pushing forward the unburnt parts of the charge, and also the bullet, to some distance, before that portion of the powder which lies next to the bullet is actually ignited. In doing this, the gas will be resisted, to a certain extent, by the weight and friction of the bullet; and therefore, from its great expansive force and subtle quantities, it will rush, in part, through the grooves, *if deep*, until the bullet has become so thoroughly expanded, by the force of the rest of the charge pressing behind, as to fill the grooves up completely, and so prevent any further escape in that direction. Thus we see that *deep* grooves *at the breech*, while they are of no earthly use, are very great evils; for they not only reduce the beneficial effects of the charge *behind* the bullet, by allowing a portion of the gas to escape, but they add to the resistance in front of it, by allowing that portion of the gas which does escape to *mix* with the already condensed air in the barrel, adding to its already great resisting force.

It appears, then, clear, that the American ball practice was not improved in consequence of the grooves being designedly made *shallow* at the muzzle and *deep* at the breech; but, simply, because the grooves were *less* in depth than those in their older arms—they being ·020 inch at the breech, and about ·012 at the muzzle; and, moreover, that a *great portion* of each new barrel was made *shallower*, than even their old arms were, at the muzzle itself. In fact, there appears nothing whatever in the American practice to warrant the conclusions which they came to, when they reported that "the superiority of the decreasing over the uniform depth for grooves is confirmed."

The idea of making the grooves shallower at the muzzle than at the breech is due to Capt. Tamisier, of the French Artillery; but it was merely *a work of expediency;* to enable the French authorities to convert the muskets of 1842 into rifles. The grooves were made ·020 inch deep at the breech, but were gradually decreased towards the muzzle, where, in consequence of the *thinness* of the metal, they were made only ·004 inch deep.

There are no scientific principles involved in such a proceeding; nor was it even attempted to say there were, though good results accidentally followed the suggestion. The Americans, we have seen, have adopted this plan with their new arms; but they attach, most certainly, an undue importance to it. Indeed, it appears plain enough, that neither they nor the French had discovered the true cause of the

improved shooting, or they would not have persisted in adopting so great a depth of groove at the breech end of the barrel.

The French and Americans recommend that "there should be an *odd* number of grooves—in which case," as they say, "a groove will be opposite to a *land;* for when the ball is expanded, each land," as they tell us, "tends to push the opposite part of the ball into a groove; consequently the ball is less deformed than when the number of grooves is even, when a *land* would be opposite a *land*, and a *groove* opposite a *groove*." This idea originated with the solid *à tige* bullet of the French; but, as it refers to a *soft* piece of metal, the argument has no foundation whatever to rest upon. It is, therefore, a matter of no moment whether the grooves be odd or even, for that, in a great measure, must depend on the calibre of the barrel—as, the *depth* being first determined, the grooves should be made *broad* enough to merge up to very narrow lands, *without leaving any sharp edges.*

The Americans have adopted "three grooves, *equal* in width to the lands, and *rounded* in shape" (or rather, *rectangular*, as they have *square* edges), "which," the report says, "take a firmer hold on the bullet, with the same depth of cut, than the *circular* ones"—the circular ones being, of course, as deep only in the centre of the groove as they incline up gradually to the edges of the lands. Notwithstanding the opinion, however, which the Americans have formed on this important subject, I feel that I have good grounds for dissenting entirely from their conclusions.

By making the grooves *circular*, and *increasing* their number, the depth may be reduced by nearly one-half—a very great desideratum—and still have a better and more equal hold on the bullet: the grasp of the spirals, or grooved parts, being nearly doubled. The French have, in the aggregate, more than 1 inch of the circumference of the bore—the Americans have ·840 inch, and the English have ·945 inch—taken up by the lands alone, which is the cause of a great and unnecessary amount of friction, and consequent retardation in the velocity of the bullet; for be it remembered, that, in the *act* of expanding, the bullet is also in the act of moving forward; and until it is fully expanded into the grooves, the pressure and retarding friction is caused by the *lands* alone, and which, being so broad, must also, to a certain extent, retard the quick expansion of the lead into the grooves, permitting a greater portion of the gases to escape.

By making the grooves shallow and more numerous, and, consequently, the lands very narrow, we economize the powder (a point of no small importance); as two drams can then be made as effective as two drams and a half when a portion of the gases is not only permitted to escape, but to create an extra resistance in front of the bullet, instead of being restricted to a pressure behind. As narrow lands offer less resistance to the expansion of the lead—the atoms or particles of lead separating more quickly to one side and the other—another most important advantage is gained by their adoption; for, as shallow

grooves are sooner filled up, the *lead* of the bullet will be in contact with the *bottom* of the grooves during nearly *the whole period* of its motion in the barrel, and its original shape will thus be less liable to be altered or destroyed. Indeed, to this very fact more than ordinary *precision* is always due.

As regards the best degree of spiral, the Americans think that "a greater twist than one turn in *six* feet increases the lateral deviation of the bullet;" and that "this deviation is variable, increasing in a greater ratio than the distance fired; and that it is greater, as the rotatory motion of the bullet is made more rapid." "In the guns giving a twist of one turn in four and five feet, it was found necessary to readjust the sights for long distances; therefore, a greater twist than one turn in *six* feet," they say, "is not necessary nor advantageous." This opinion rests, however, upon no true foundation. It is merely an idea borrowed from the French, along with the rifle *à tige* and bullet which the Americans used in making their experiments. In fact, there is nothing in their experiments to warrant such an opinion—especially when we learn that they were carried on not only with the rifle *à tige* and bullet, but also with a rifle of their old musket calibre, and some bullets of the most unscientific construction imaginable. Fig. 6 represents one of these bullets—A, being a section; B, the bullet, with the plug partly inserted, ready for loading.

The French entertain exceedingly odd ideas with respect to the different degrees of twist in the barrel. In trying experiments with *long* bullets, they report

that "in proportion as the ball increases in length, and consequently in weight, grooves with greater inclinations, but smaller charges, should be used." "With weak charges of powder, the twist of the grooves," they say, "may be very great; with powerful charges, the inclination should be very slight." This is certainly very erroneous doctrine; for experience tells us that, in proportion as the bullet is made longer, it is not only indispensable that a more rapid rotatory motion should be given to it, but that the effects of the greater inclination in the spiral will be lost if the *propelling* force is not also increased. The bullet should, therefore, be driven rapidly through the barrel, or a greater twist in the spiral will be of no avail.

Last year the French Minister of War issued a programme, in which it was announced—1st. That all the infantry musket barrels were to be cut down to 40 inches, leaving them still one inch longer than the Enfield Rifle barrel. 2nd. That they should receive four grooves of ·028 inch in breadth, ·008 inch in depth, and of the same degree of spiral as those already in use—they being a little less than one turn in 6 feet 6 inches. 3rd. That they should have but one sight fixed, which was to be fixed on so as to give a convenient point blank range. 4th. That as it was not necessary that the fire of infantry soldiers should exceed 600 metres (or 656 yards), it would suffice if the projectile which was destined for them had an accuracy and a range appropriate for that distance. 5th. That the special conditions of the projectile

should be—not to require the iron cup; to weigh at most 500 grains; and, particularly, to have the lowest possible trajectory.

It would be unfair to criticise this programme too closely, as it is evidently a mere work of expediency, like a former one, to enable the French to make the best use of their old muskets; but still the programme might have been drawn up in a much more practical and scientific manner, so as to have enabled the Commission to carry it out with better results. The turn of the spiral (1 in 6 feet 6 in.) is certainly quite enough for so short a range as 650 yards; but the lands are by far too broad and the bullet too light for the calibre of the barrel (it being as much as seven-tenths of an inch in diameter) to permit of the lowest possible trajectory being obtained. In fact, the trajectory, in such a case, must be a very high one; much higher, indeed—and their experiments shew it—than either the English or the American. It is no wonder, then, that the Commission found it impossible, as they remarked, to satisfy all the conditions which were imposed upon them by the Minister of War.

If friction, and every other kind of resistance, be diminished to the utmost possible limit, so that the bullet may receive the full effects of the charge and be driven rapidly through the barrel, a comparatively *slow* spiral may be made the means of giving a *rapid* rotatory motion to the bullet; for, in such a case, the higher the initial velocity, the greater will the rotatory motion be, as the bullet must pass through the barrel

quicker, and therefore take the *amount* of turn quicker; and, as a matter of course, it will make a greater number of revolutions in a certain portion of time.

If we take a toy called a teetotum, and spin it on a table, we can only give it a full turn before we let it go. If we desire to make it spin longer, we make it spin quicker, by giving it a quicker jerk; but in doing so, we still give it only the same amount of turn. Any attempt to give it a greater amount of turn before letting it go, results only in diminishing the power we have over its spinning motion. In like manner, if we wish to make a peg-top spin longer, we do not turn the string round it oftener, but we simply throw it with greater velocity to the ground. If we throw it with less velocity it spins more slowly, and turns over on its side sooner.

This should teach us that there are other and more beneficial modes of obtaining a high velocity of rotation than by rapid twists in the spiral, which, of course, require deep grooves to prevent the bullet from stripping. Take a three-grooved rifle for instance, having the lands as broad as the grooves, and run a shallow groove up on each land. The result will be, that the bullet will pass out with greater velocity, in consequence of there being less friction; and it will rotate as many times in a second as it would have done had it been projected from a barrel with one turn in 5 feet, instead of one turn in 6 feet; and, what is of very great importance, the original shape of the bullet will be less liable to be destroyed.

When firing *with equal charges*, too great a turn in the spiral will cause a diminished range, in consequence of the greater friction on the bullet causing it to leave the muzzle with less velocity; and too little turn will cause a great want of accuracy. In like manner, the greater the length of the bullet (the turn of the spiral being the same), the less the initial velocity will be which can be imparted to it, in consequence of the greater friction caused by the greater length of the projectile.

Taking into consideration, then, all the experiments which I have made myself—all I have witnessed elsewhere, and all the experimental reports I have read on the subject—I still adhere to the mode of grooving which I adopted and recommended in the autumn of 1853, and which I again brought before the Enfield authorities in 1855. The plan, however, was not even acknowledged or alluded to in return, but it was quietly laid on the shelf, where it may possibly remain until produced again, with some slight modification, as the suggestion of some other person; for, as sure as *large* calibres are giving way to *smaller* calibres, so sure also will *broad* lands give way to *narrow* ones.

The mode of grooving which I then recommended, and still adhere to, is represented by Fig. 7; drawn also on a larger scale, for the sake of distinctness.

As regards the proper degree of twist, I have found that one turn in 5 feet is ample, but not too much, for a range of one mile; and that a barrel, 2 feet 6 inches, is length enough for any rifleman.

With reference to the remarks which I made in my last Lecture, relative to deer-stalking, I may here observe, that, as the range for that sport is generally limited to a much shorter distance than military rifle firing, a twist in the spiral of one turn in 7 or 8 feet will be quite sufficient to keep the bullet spinning rapidly, as long as it will be required; so that, by reducing the degree of twist as much as the circumstances of the case will admit, the velocity is made greater, and the trajectory proportionately lower; this being of as much importance to the deer-stalker, as a low trajectory is to the military rifleman.

This mode of grooving a barrel leaves no sharp edges on the bullet to be affected by the air in its passage to the object aimed at. The barrel is also, in consequence, much easier cleaned, independently of its being less subject to fouling. Moreover, the friction in such a barrel is so little that a properly fitting bullet may be withdrawn with one hand, which, in the three-grooved rifle with broad lands, would require, as we have often seen, two men—one holding the rifle, and the other with both hands at the rod, drawing the bullet out.

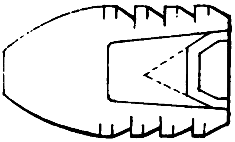
The Americans some time ago tried a mode of grooving somewhat similar to this; but though they admit that the shooting was excellent, they report that "it is *thought* that the lands are too narrow and delicate for a service weapon." Any man, however, on looking at the diagram, will see that the grooves join the lands so imperceptibly, and are so shallow (being only ·008 or ·010 inch, according to the size

of the bore), that such a weapon might indeed be called a *smooth-bore* rifle. But if the Americans will still persist, against all reason, in making their grooves so deep as ·015 inch at the breech, it would certainly be an act of great folly were they also to adopt very narrow lands, as it is impossible to make deep grooves without making the edges sharp; consequently, in such a case, the lands would be made delicate as well as narrow.

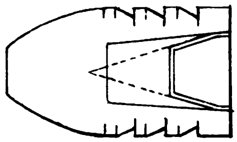
I have had some difficulty in condensing these remarks, so as to bring them within the time allotted for the delivery of a Lecture; I trust, therefore, that every allowance will be made for disjointed parts and abridged explanations. A free and open discussion, however, on so important a subject—supported as it ought to be, as far as possible, by experimental facts—is the only plan, I believe, that will keep us, as a military power, in the van of all improvement.

Minie Bullets.

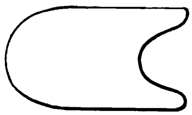
1849.



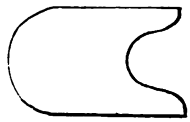
1854.



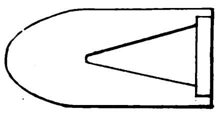
The Pritchett.



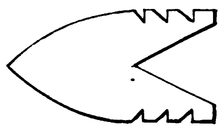
American Pritchett.



The Disc.



The American.



LECTURE III.

ON THE FALSITY OF THE PRINCIPLES ON WHICH THE PRESENT SERVICE WOOD-PLUG AMMUNITION IS CONSTRUCTED. WITH ILLUSTRATIONS AND EXPERIMENTAL PROOFS.

COLONEL W. H. SYKES, M.P., F.R.S.,
&c., &c., &c.,
IN THE CHAIR

When I was requested by the Directors of the United Service Institution to give one or more lectures on the subject of the rifle, I responded to their call with the greatest cheerfulness, though I had never attempted to give a lecture before.

In accordance with their wishes, I delivered two lectures; one on the 26th of March, and the other on the 9th of April, and the language I made use of was, I think, calm and temperate in its character. My first lecture was "On the rise and progress of the Minie expansion system, and the mistaken notions which it has unhappily engendered." I endeavoured to expose that system, as being false in principle, but I reflected on no man, individually,

for believing in it; my object being simply to shew, with the aid of experimental facts that the whole system was a fallacy, a complete delusion.

What then was my surprise, when, on the 28th of May, Colonel Wilford, the Chief Instructor of Musketry at Hythe, after having delivered a lecture on a different subject, took that opportunity, without entering into any particulars, of denouncing my opinions generally, declaring, that, as he was a believer in the "Minie" system, and had taught its principles for three years, if the principles which I advocated were acknowledged to be true, he and others must be looked upon as imposters!

his was a dóctrine which appeared to me to be quite new, and just as untenable as the "Minie" system itself; for though a false theory may be propagated so as to impose upon the great bulk of mankind, it does not necessarily follow that even the author himself should be considered an imposter; nor does it follow that those who endeavour to expose the errors into which he has fallen, should be held up and denounced as presumptuous and ignorant men.

I ask you, Gentlemen, with all due humility, in what state would science have been at the present day, if Newton, and others, had been deterred, by any menace whatever, from exposing the fallacies which had crept into the writings of a Copernicus, a Galileo, or a Kepler? Great were they all! No man calls them imposters! Yet who now takes for granted all that they have asserted? In their

writings we find theories, which now create a smile at their absurdity; but it is only because time and further observation have refuted them.

The celebrated Robins was not satisfied with the principles of gunnery as he found them; but taking the floating theories of his time he employed his great intellect in giving them system, character, and definiteness. Euler and Hutton, however, were not satisfied with believing in all that he had laid down as incontrovertible facts;—that the pressure of ignited gunpowder, for instance, was only equal to a thousand atmospheres, or that it exploded instantaneously. No man denounced them for exposing the errors into which Robins had fallen; nor does any man call Robins an imposter for having believed that his own conclusions were true.

The general acceptance of any theory is no proof that it is the most true and most perfect that will ever be presented; nor is it any reason why its errors should not be exposed and condemned. If the inventors of the "Minie" system choose to frame a doctrine, in which Colonel Wilford chooses to believe, is that any reason why I should be precluded from objecting to it, and exposing its want of truth? Colonel Wilford tells us that he not only believes in the system, but has taught its principles in the School of Musketry for three years! That is the very reason, I submit, why he should be cautious in denouncing the opinions of others, until he has heard every objection, and witnessed every proof that can be brought against the system;

remembering, that we should never remain satisfied with ideas to which the least doubt can be attached; and, that mere theoretical instruction must prove highly pernicious, if the laws of nature declare it to be false.

Without being deterred by what Colonel Wilford has said in support of the "Minie" principle, I shall, with your permission, Gentlemen, apply myself to a further illustration of the erroneous impressions which have led to so general a belief in the truth of that system, whether by iron-cup or wood-plug agency.

When delivering my first lecture, I regretted that time did not admit of my entering so fully into detail as I then could have wished. Now, however, I hope to be able to lay before you such additional facts as will enable you, one and all, to form your own, and, I trust, a correct opinion on the subject.

The framer of a doctrine, if it be built on a false foundation, is apt to stumble and expose its errors, if objections are raised against it from time to time. Feeling thus assured that further enquiry relative to the "Minie" principle, would bring to light more practical inconsistencies which would prove fatal to it, I applied for, and obtained from good authority in Paris, the last version of the system. In my first lecture, I only gave the earliest version, that of 1849, which, in contrast to the latest, that of 1854, I shall now repeat.

In 1849, Captain Minie says, that "on fire

being communicated to the charge, the gases developed act powerfully on the little iron-cup and cause it to penetrate deeper into the bottom of the ball, and, in consequence, effects the forcing of the latter against the sides of the barrel."

Now, as this version varies considerably from the last, that of 1854, and as the last is in itself a great curiosity, I shall give it here entire, to enable those who feel an interest in the subject to draw their own conclusions.

"The first gases," says the inventor, "being produced, a portion forces itself into the space between the ball and the sides of the breech of the barrel; and the other exercises its force on the base of the projectile. The cup, which receives the greater part, and which, besides, has a density and volume much less than those of the ball, ought evidently to move more quickly than the latter, and exert itself to penetrate into the cavity to expand the sides. The resistance which is opposed to this expansion, by the cohesion of the lead, and the pressure of the gases which have penetrated between the sides of the barrel and the ball, causes the action, at the first moment it is impressed on the cup, to communicate itself to the entire projectile, and makes it advance, before the cup has been able to drive itself into the cavity. Nevertheless, after a very short time, and hardly sufficient for the ball to arrive at a quarter's length of the barrel, the cup drives out the lower base of the ball, and forces it to mould itself into the grooves.

In proportion as the cup forces itself into the cavity, it expands successively all the rings which follow the first; the air, in the cavity, being compressed by the cup, expands, at the same time, the anterior rings; so that, when the cup has arrived at the bottom of the cavity, all the cylindrical part of the ball is expanded, and the expansion is complete.

"The pressure, which the gases exercise against the interior side, prevents the contraction of the lead, which the friction, experienced by the ball, might occasion; and maintains, and even augments, its expansion, as much as the usage of the paper renders necessary. It arrives, therefore, at the muzzle with an expansion, as exact as that which it had immediately after the action of the cup."

Now, Gentlemen, I shall be able to show, presently, that the greater part of what I have now read, is fanciful and unreal: mere speculative hypotheses, unsupported by even a single fact. In the mean time, let us see what change took place in the system, about this period.

Before giving any definite orders for the adoption of the "Minie" ball, the French Minister of War wished to elucidate the matter still further by more extended experiments. He, therefore, gave orders to use it in several regiments; to fire it comparatively with the spherical ball, and to compare the results with like experiments made some time previously with the oblong ball.

A rifled musket of a new pattern was used

having a calibre of only 697 inch. "It thence resulted," the report says, "that the windage became insufficient, that the ball had not an accuracy so good as in the first experiments, and that it became inferior even to the oblong ball." Nevertheless, these experiments led, with reference to the form of the ball, and that of its cup, to certain alterations, which were considered improvements, and which it may be useful to mention here.

"The calibre of the ball was reduced ·003 inch; the entry of the cavity, and the base of the cup, were made ·429 inch, instead of ·433 inch; and the reduction of the calibre of ·020 inch, which the inventor had adopted in the lower part of the projectile, was suppressed as useless."

Now follow some remarks, relative to certain alterations, which are well worthy of particular attention:—

"As the air," the report continues, "which is compressed in the cavity of the cup, had no way of escape, it drove out the latter from the cavity, when its expansive force was no longer counterbalanced by the pressure of the gases from the powder."

This is a free admission, you will perceive, that the iron cup was liable to be forced out of the bullet, though the real cause it seems was not then understood. But to proceed—

"As the cup, thus projected, might occasion accidents, and affect the accuracy of fire, it was thought that its expulsion would be prevented, by augmenting the height of the cup, and giving to its

sides such a thickness only, as would cause it to *yield* to the pressure of the air in the cavity, and allow it to pass out by its sides, as the cup entered deeper.

"With this object in view, the cups were made ·032 inch in thickness, instead of ·040 inch; and ·315 inch, in depth, instead of only ·197 inch. At the same time their size at entry, was reduced to ·425 inch, to the end that their introduction into the cavity might not press out the sides, and augment the calibre of the ball. These various alterations," says the report, "produced the desired effect; for not merely did the new cup *not* fly out from the cavity, but additional accuracy was gained."

We have here the action of the iron cup, as also its form, described, according to the latest interpretation.

That the cup last constructed, is not so liable to be forced out of the bullet, as the former, is easily accounted for, by the simple fact, that its *shape* is better adapted for being held firm in its original position, by the contraction of the lead; and on this account, alone, it makes better shooting. This may be perceived on glancing at the diagrams of both bullets; if the tendency which an obtuse or thick wedge has to be pressed out, be borne in mind.

From what I have quoted, it will have been remarked, that the metal of the cup was made thin enough, as the inventor erroneously believed, to allow of the small quantity of air, contained in the cavity of the bullet, to escape, by compressing or causing

the sides of the iron cup to yield to its elastic force, while the cup was in the act of penetrating deeper into the cavity.

How the edges of an iron cup, whose sole object it is to act like a wedge, and force out the sides of the bullet into the grooves by the force of the gases from the powder pressing behind, should, *at the same time*, yield, or give way, to the force of a small quantity of air, no larger in bulk than a common pea, however much the elastic force of that small quantity might be increased by the heat, must be a mystery to every practical man!

The inventor must have been totally ignorant of the fact, that the cup, or domed form, bears a greater amount of pressure than any other form whatever; because it allows the pressure to act only so as to compress all the atoms or parts at once, and in the same degree. An article so fragile as even a wateh-glass, because of its arched or domed form, bears a very hard push before it is broken. A full cask falls with impunity, where a strong square box is dashed to pieces. A thin globular flask of glass may be corked and sent down many fathoms into the sea, and will resist the pressure of the water around it, while a square bottle, with sides of almost any thickness, is crushed to pieces. But it is unnecessary to multiply examples; suffice it to say, that if the sides of the "Minie" cup were made thin enough to yield or give way under a hundred times the pressure which the quantity of air in the cavity exerts, it would be rendered

utterly useless for any practical purpose whatever; for the force of the explosion would be sufficient to crush it like a piece of crumpled paper.

I have called the "Minie" system a fallacy,—a mere delusion; but, if studied carefully under all its peculiarities, one cannot help calling it a palpable absurdity, a gross imposition on the common sense of man. It is no wonder, indeed, that, though it has been often tried in France, with all its modifications, it has never yet been generally adopted, but has always given way in favour of some other plan.

In further illustration of this extraordinary delusion, let me now draw your attention to the present wood plug bullet of our own service; as that is constructed on the same erroneous principles, in imitation of the "Minie" cup. Its theory is as follows:—"The plug acted upon by the force of the gunpowder, is driven violently up the hollow like a wedge; and the lead, giving to the pressure, is forced outwards, increasing the size of the bullet, so that the bore is filled by its expansion, and all windage completely destroyed."

On this table I have placed before you a quantity of these bullets, dug from a mound of sandy earth, into which they were fired from an Enfield Rifle, at different distances; and I here declare, that they are placed before you, as they were dug from the mound, without any selection whatever, and may, therefore, be taken as fair and impartial spe-

cimens of all such as miss the target, and penetrate into the earth.

Out of 193 bullets, you will perceive that only 62 have the wood plugs remaining in them; the rest having been all forced or squeezed out by the contraction of the lead, caused by the forward pressure of the powder gases acting behind.

I have divided these bullets into different lots, in order, the more clearly, to explain the peculiarities of each.

Those in the first lot are nearly as perfect in shape, as when they left the muzzle of the piece; showing that they were fired from a considerable distance, and, consequently, their velocity being much reduced, they met with little resistance, or reaction, from the sand, to injure the form in which they left the rifle.

Of these, a large proportion have the wood-plugs thrown out; a smaller portion retain them in their original position; laughing, as it were, at their inventors, who have the assurance to call them "expanding agents."

I may here, by way of parenthesis, remark, that very perfect specimens of this sort may always be extracted from a mound of finely sifted sand, if fired into from any distance greater than 200 yards; as the reaction of the sand, at a shorter distance, injures, less or more, the original shape of the bullet. It may also be here remarked, that no class of bullets show the plugs driven in, but those which have struck with considerable velocity.

The second lot, you will see, have all parted with their plugs, in their passage up the barrel; and are much disfigured by the reaction of the earth; having been fired at a distance of only 50 yards.

The third is the lot, however, to which I wish more particularly to direct your attention, as they are similar to the specimens which have so grossly deceived the inventors of the wood-plug; and are the sorts on which they rely for proofs of the truth of their system!

By examining these bullets thoroughly and carefully, we act honestly towards their advocates, and, at the same time, we prove to ourselves, more convincingly, the falsity of the system; for, in this case, as in many others, it is our judging and arguing upon a partial view of things that exposes us to mistakes, and pushes us into absurdities, or at least to the very verge of them.

These bullets, it will be seen, have the wood-plugs apparently *driven* in to a distance of from $\frac{1}{16}$ to $\frac{1}{8}$ of an inch. To such specimens the advocates of the system point with confident triumph and say, Look there! Do you mean to tell us that these plugs are not driven in? I reply, that they certainly appear to have been *driven* in; but I deny that they were placed in that position by any action of a *driving* nature, or while they were *inside* the barrel. Then how could they have been placed in that position after they left the barrel? That is the question; and if I can answer it by showing that their present position is the result of

other forces than those of gunpowder; and also, that all their motions have been strictly in accordance with the laws of nature; I trust the answer will be satisfactory to every unbiassed mind. On the other hand, as our object should be to endeavour to arrive at the *truth*, I would respectfully entreat those, who are at present firm believers in the "Minie" doctrine, to lay aside passion or prejudice for a few moments, and endeavour to listen to me, as impartial hearers, and then judge according to the evidence.

There are few errors more common than that of supposing that the movement of a body, once set in motion, ceases because its force is worn out or spent. The state of motion is as natural to a body as that of rest; and no change can be made in its state, whether the setting it in motion when at rest, or the bringing it to rest when in motion, without the application of a force. This is taught us by common experience.

The idea that matter has a greater tendency to the state of rest than to that of motion, results from the fact, that all the motions of which we see the commencement, gradually become weaker and weaker, and at last cease altogether. Thus, when we roll a ball over a smooth road; its velocity becomes less and less, and at last it stops. But in this, as in other instances of bodies moving on the surface of our earth, there are causes which are continually acting against the movement, and are,

therefore, constantly diminishing its force. These causes are *friction*, and the *resistance of the air*.

That the motion of a body, when not retarded by these or any other opposing causes, will continue for an indefinite period, there is the most satisfactory evidence. But, in order to have absolute proof of the *permanence* of motion, when there is no retarding force applied to check it, we must look towards a class of bodies, which are not influenced in their movements either by friction or the resistance of the air. These we shall find among the heavenly bodies. Their movements have continued for ages, without the slightest tendency to diminution; they commenced when they were first impelled by the hand which launched them into space, and they will continue to traverse the paths they still describe, with the same undiminished force, until time is swallowed up and lost in eternity.

These remarks might appear somewhat irrelevant to our present subject, if it could not be shown, that the very same energy which now upholds the planets in their majestic orbits, has also been exerted, as much, in sustaining the motions of every atom which compose these bullets; for when we say that the planets continue to revolve with the force impressed upon them at the creation of the system, nothing else is meant than that they have received no new impulse:—that they have not been affected by any forces, either retarding or accelerating. These great truths—the incontrovertible laws of nature, are too often for-

gotten, or entirely neglected, by the littleness of human nature, when endeavouring to reconcile cause and effect.

This naturally leads us to the consideration of the first of the three Laws of Motion, which was stated by Newton in the following terms :—" Every body must persevere in its state of rest, or of uniform motion in a straight line, unless it be compelled to change that state by forces impressed upon it." From this we are led to understand, that it is one of the fundamental properties of matter, that it tends always to remain in the same state, whatever that may be. This property is termed *inertia.*

The effects and phenomena which hourly fall under our observation afford unnumbered examples of the inability of lifeless matter to put itself in motion. But it does not happen that we have the same direct and frequent evidence of its inability to destroy any motion which it may have received. And hence it arises, that while no one will deny to matter the former effect of inertia, few will at first acknowledge the latter. Indeed, even so late as the time of Kepler, philosophers themselves held it as a maxim, that "matter is more inclined to rest than to motion;" we ought not, therefore, to be suprised if, in the present day, those, who are not sufficiently conversant with physical science, are slow to believe, that in a compound body, made of lead and wood, like these bullets, the force of motion in the one body will continue, after it has been arrested and destroyed in the other.

Reason, assisted by observation, will, however, soon dispel this illusion; for experiments show us in various ways, that the same causes which destroy the motion in the lead, does not, at the same instant, destroy the motion in the wood; a clear manifestation of the principles of inertia, or the *permanence* of the force of motion.

This property of inertia, and the tendency to permanence of motion, which has been so strangely overlooked by the advocates of the "Minie" system, may be easily traced in almost every case of motion. A few practical and familiar examples, taken from the occurences of ordinary life, may, therefore, be useful in verifying the general law, and in impressing it upon the memory. Moreover, if we begin with examples, on a large scale, and gradually reduce them until we arrive at the point in question, we may be the more successful in bringing home to the mind the general principle, that motion once communicated is as naturally permanent as rest.

The force of a body's motion is precisely equivalent to the force expended in producing it; and the force of this motion exists in *every particle* of the moving body, hence when such a body is to be brought absolutely to a state of rest, the force of motion must be destroyed in every particle of it. But the motion of any body is never destroyed *instantaneously;* because there are no bodies which are so perfectly hard, that their particles cannot be in some degree displaced upon one another.

Now, if a leaden bullet be thus brought to rest

by encountering an inmoveable object, the motion and force of motion in those parts of it immediately in contact with the obstacle will be destroyed at once. The parts of the bullet immediately behind them retaining, however, the force of *their* motion, will press directly on the first, those behind these, on *them*, and so of the rest, until the momentum of each, in succession, is destroyed by the resistance of those before it.

This action is illustrated, on a large scale, on the awful occasion of a ship in rapid motion being suddenly arrested by a sunken rock; all things on board, men, guns, and furniture, start from their places, and are dashed forwards; the inertia or motal obstinacy of the stern parts of the ship pressing forward, sufficient to crush and break the bow against the rock.

The spreading out of the lead, when the bullet strikes with great velocity, like some of these specimens before us, is also illustrated, on a large scale, by the frightful accidents which have several times occurred to railway trains, in consequence of the sudden and complete stoppage of the engine in front by a fall of earth, by running against a bank, or by other causes. The whole train may be regarded as a single mass, of which the cohesion among the separate parts is not sufficiently strong to resist the force created by the momentum of the hinder part, when in rapid motion; for this momentum of the hinder part of the train causes the carriages immediately behind the engine to be

so pressed on by them, as to be crushed to pieces. In a calamitous accident which occurred on a railway, in France, some years ago, it is recorded that the crushed carriages actually formed a pile of thirty feet high; so great was the force created by the continued tendency to onward motion in the long train behind.

In the frightful accidents which have recently occurred on some of the railways in this country, by a sudden stoppage in front, we have fearful illustrations of the law of inertia, or the tendency to permanence in the force of motion. In one case, the guards van forced itself into a carriage in front of it, crushing and breaking the bones of several persons who were sitting there. Several of the carriages were literally smashed to pieces, by others pressing behind them, leaving in their places nothing but a mass of splinters. A very narrow, but most extraordinary, escape is related, "Several ladies were seated in a compartment of a first-class carriage, which came in contact with a stationary obstacle capable of resisting a weight of many tons. The obstacle itself gave way, but its resisting force was so great, that it tore away the entire side of the carriage; the ladies were all thrown forward into an adjoining field, but all escaped without serious injury, save one." This was the language used in the papers of the day; but, looking at the occurrence as an illustration of the law of *inertia*, it would be more strictly correct were we to say, that the side of the carriage, which met with no

resistance, rushed past the obstacle, tearing itself from the other side of the carriage, which struck the obstacle in its way.

Let us now add the wood plug to the leaden part of the bullet, and endeavour to illustrate the motions of both, as a compound body.

If a horse moving with speed, for instance, be suddenly stopped, by any cause which does not at the same time affect the rider, the man will be precipitated in the direction of the motion; because by reason of his *inertia*, he perseveres in the motion which he shared in common with the horse which transported him, and is not deprived of that motion by the same cause. Again: if a man stand upright in a boat, as it approaches the shore, he will fall forwards, if the boat suddenly strikes the ground; for its motion being checked, his own inertia will tend to carry forwards his body. It was from the same law of *inertia* in producing a tendency to continued motion, that the driver of one of the trains, already alluded to, was hurled over the chimney of the engine; and the passengers dashed from the backs of the carriages to the fronts of them.

These illustrations may be quite sufficient to bring home to the mind the general principle, that motion once communicated to a body has a tendency to continue; and that it can only be diminished by a force opposed to it. One or two more examples, however, having a closer analogy to the point in question, may still be usefully introduced.

The mode commonly adopted by workmen, of fixing tools into handles, is founded on the same principle, though *they* know nothing but that it is successful in practice. Thus, in fixing a chisel or a file into a hole in the end of a handle, the former is placed in loosely, and the lower end of the handle is then struck smartly upon the work-bench. This has the effect of suddenly arresting the handle, whilst both it and the iron are in rapid motion; the iron then buries *its* lower end in the handle, by the continuance of its own movement. The handle may, in this case, be considered as representing the leaden part of the bullet, and the chisel or file, the iron cup or plug.

Let us now take this large leaden ball, which has a cavity extending through two-thirds of it. Into this cavity I insert slightly a wooden plug; and then strike the opposite end of the ball smartly on this iron block.

It will now be perceived that the plug has entered deeper into the lead, without the plug itself having been even touched; just the same as the wood plugs in these rifle bullets have done.

It may easily be understood that had this large ball been going at the rate of 1,000 feet, or more, per second, as these bullets must have been doing when they struck the obstacle, the plug would have entered much deeper than it has now done, with a velocity of only about two feet per second. If it were, however, struck several times on the iron block, which would be in some measure equivalent

to greater velocity, it would be difficult to withdraw the plug again, so firmly would its own tendency to permanence of motion cause it to bury itself in the cavity of the ball.

It may be urged by some, that although all these examples are strictly in accordance with the laws of nature, a little bit of wood, so light as one of these plugs, can have no force of motion within itself worthy of being taken into consideration. This however, it is easy to prove, would be a very mistaken notion.

The amount of force with which a body in motion will strike against a fixed obstacle, depends upon two conditions,—its weight, and its velocity or rate of movement. If two bodies of the same weight are moving with different velocities, *that* one will strike the hardest which is moving the fastest; or if two bodies of different sizes be moving with the same velocity, the larger will strike the hardest. Thus we see that the force depends upon both the weight and the velocity; so that a small body, moving very fast, may strike with more force than a very large body, moving at a comparatively slow rate; or a very large body, though moving slowly, may have more force than a much smaller one having many times the speed. The force of a body in motion, thus compounded of its weight and velocity, is termed its *momentum;* and it is estimated by multiplying these two quantities together. In this manner, we may compare, without any difficulty, the momenta of bodies having very different weights and rates of mo-

tion ; and may ascertain which will be most effectual for a given purpose.

Thus if the velocity of these rifle bullets, weighing 530 grains each, be 1,000 feet per second, their momentum will be represented by the number 530,000. Now as this large ball weighs about 2 lbs., or 13,900 grains, and its motion, moved by the hand, is about 2 feet per second ; its momentum will be represented by the number 27,800 ; being only the twentieth part of the momentum of the rifle bullets ; a fact, which ought to convince the greatest sceptic, and most determined stickler for the "Minie" system, that these wood plugs small and light as they are, had force of motion in them quite sufficient, when the bullets struck, to cause them to bury themselves as deep in the bullets as they have done, before the force of their own motion was completely destroyed. This will be the more apparent, when we consider how far the plug buries itself in the large ball, with only the twentieth part of the momentum ; and that the wood plug in the rifle bullet is quite as heavy in proportion to the lead, as the other is to the large ball ; and further, that the velocity of the rifle bullet, at only 50 yards from the muzzle of the piece, must have been much greater than 1,000 feet per second. This will be still more apparent to many Gentlemen who are now present, when I direct their attention to the fact, that a leaden bullet striking with a velocity of 1,000 feet per second, will leave a mark on an iron target, sufficient to show where it struck ; while, with all my force, I could not make

an equal impression with this large ball on a piece of iron.

I shall now, Gentlemen, hand over to you a few of these bullets for inspection, after which, you will be kind enough to return them to me again, in order that I may make an experiment with them in your presence.

On examining these bullets, you will perceive, what I have already stated, namely, that the wood plugs appear to have been *driven* in from $\frac{1}{16}$ to $\frac{1}{8}$ of an inch. This, I have endeavoured to explain, according to the law of *inertia*, has not been effected by any *driving* or forcing action of the gunpowder, but by a force of a very different character. Now, it is well known that in metals, the degree of resistance to a compressing force is much greater than the tenacity; whilst in wood it is much less. This knowledge, however, does not appear to be one of the qualifications of the wood plug advocates; for if the lead around the edges of these plugs was cut carefully away, and the plugs measured by a pair of fine callipers, it would be found that the plugs are now less in diameter, at the edges, than when they were fitted into the bullets; and that, therefore, instead of acting as "expanding agents," their edges have actually been compressed into less bulk, by the united action of their own force of motion, and the contraction of the lead.

To cut the lead, and measure the plugs, would be a work of time; but I can satisfy you on this point, in a much more expeditious manner. With

this small gimblet, I shall withdraw a number of the plugs, and fit into the cavities others which have not yet been fired. It will then be seen that no expansion, whatever, could have been caused by the former plugs, as the new ones will be seen to fit just as tightly at the base of the bullet, as the others did originally.

I should here again draw your attention to the very important fact, that no bullets have the cups or plugs driven in so, but those which strike an obstacle with great velocity: a sufficient answer to all who fancy that the cups or plugs are driven in by the action of the powder inside the barrel.

Among the specimens before us, there are some which have their cavities considerably enlarged, instead of being contracted, as they more generally are. On looking at these, however, we must not be deceived by appearances, and imagine that this must have been the work of the wood plugs; for it will be found that, in all such cases, the cavities are even larger than the plugs are themselves. It is well known to those who have carried on extensive experiments, that some bullets, just on leaving the muzzle of the piece, are thus affected by the lateral expansion of the flame in its struggle to escape; aided by the plug having been previously loosened from its place. Among these bullets there are some which have been acted on in this manner in a very extraordinary degree, and though some may think that this is caused by their striking against the ground with great velocity, I have proved, incon-

testably, that such a change often takes place at the very muzzle of the rifle; though, it is true, that, on striking the ground with great velocity, this enlargement, or spreading out and turning over, is considerably augmented.

This is a subject, Gentlemen, which I could easily enlarge upon, and may yet be induced to do so on some future occasion, by presenting many additional illustrations, examples, and proofs, of a like nature, all tending directly or collaterally to show, that there is no truth whatever in what the advocates of the wood-plug system tell us, namely, that "the plug acted on by the force of the gunpowder, is driven violently up the hollow like a wedge; and the lead, giving to the pressure, is forced outwards, increasing the size of the bullet, so that the bore is filled by its expansion, and all windage completely destroyed."

Colonel Dixon, in a lecture delivered by him last season, expresses an opinion, that if the wood plugs do not assist the upsetting of the lead, "They no doubt prevent any collapsing of the sides of the bullet when leaving the barrel." In this opinion, I quite concur, as I consider it is founded on true principles;—the preservation of the sides of the bullet being of the greatest consequence; but it will be seen from the bullets now before us, that this "protecting" property, is very partial in its application, as barely a third of the plugs have remained in the bullets. This separating tendency is no doubt known to Colonel Dixon, though not perhaps to its

utmost extent, for his practice range, having a smooth piece of water and a broad road all along it, is peculiarly adapted for detecting this separating propensity; as the plugs may be seen to drop into the water, or they may be picked up on the road, showing that a small proportion only remain firm in the bullets to the end of the range.

In 1853, the Hon. Colonel Gordon published a very valuable pamphlet, in which it is stated, that, "in order to ascertain the possibility of dispensing with the iron cup used with the 'Minie' bullets, trials were made at Woolwich of bullets with cups and also without cups. The result showed that the practice *with* cups, was fully one-third better than that of bullets without cups." This is a fact which is well worthy of our special attention, as it coincides in a remarkable degree with the facts now before us; for these bullets show, that barely a third of the plugs have done any service whatever. Not such service, certainly, as Colonel Wilford's "*expanding* agency" means, but in accordance with the *protecting* theory alluded to by Colonel Dixon. One third, only, having remained in the bullets, thus preventing the edges from collapsing, aud so causing a third better shooting as reported by Colonel Gordon, with the iron cup; for it can easily be shown that iron cups and wood plugs are very nearly equal in the uncertainty of their action in the bullet.

Were I to offer any advice to Colonel Wilford, it might be deemed the height of presumption on

my part; nevertheless, I have no hesitation in saying, that it would be better, were he, at once, to abandon his ideas with respect to "expansion" on the part of the plug, and adopt those opinions which have been advanced by Colonel Dixon, relative to its "protecting" qualities. If not, the somewhat remarkable fact may yet be recorded in the history of the rifle, that the *first* instructor of musketry in the British Army, was the *last* to give up teaching a false theory!

It may now naturally be asked, If the iron cups and wood plugs are not expanding agents, what then is the true cause of the expansion of the lead into the grooves of the barrel? This is a question which is very easily answered, though it has given rise to very mistaken notions. In a Manual called the "Instruction of Musketry," issued from the Horse Guards in January, 1856, we find an answer to the question, in connexion with the Pritchett Bullet, which is good, so far as it goes, but it does not appear to me be sufficiently explanatory. It is as follows, "The bullet enters the barrel easily, but on the explosion taking place, the pressure of the air in front, and the force of the explosion behind, have the effect of dilating the cylindrical portion of the bullet, so as to make it fit the barrel tightly, precisely in the same way that compressing an orange or India-rubber ball at the opposite ends, would widen its other diameter, and so enlarge its lateral circumference."

This answer is correct to a certain extent, and is

equally applicable to all sorts of leaden bullets, whether with cups or plugs, or without them; but it must be evident to those who have studied the action of the piston in Pneumatics, that the pressure of the air in front, cannot begin to operate in a manner worthy of being taken into consideration, until the bullet has moved a considerable distance from its original position; for without this movement on the part of the bullet, there can be no condensed air in the barrel, and, therefore, no pressure from the air in front of the bullet, greater than that externally.

This may be illustrated very clearly by fitting a plug on the end of a ramrod, and covering it with soft leather, well oiled, so as to make it air tight. Then, by inserting the plug into the muzzle of a barrel, aud working it like a piston or a syringe, it will be found that the plug can be pressed into the barrel a considerable distance before much resistance is felt from the condensation of the air.

The inoperative effects of the air in front, at the commencement of the motion of the bullet being admitted, we must look for other causes of expansion, and these we shall find are, the *inertia* of the atoms of the forepart of the bullet, and also *friction*.

A bullet may be made too short to expand properly, for want of a sufficiency of *inertia;* or, in other words, for want of a sufficient quantity of sluggish atoms; and, if of extreme length, the friction and inertia may be too great, causing too

much, or an unnecessary degree of expansion, and consequently retardation to the velocity of the bullet, arising from the excessive friction. Again; a bullet may be made a few thousandths of an inch too small in diameter, reducing the *necessary* amount of friction, and allowing a portion of the gases to escape between the bullet and the barrel, during the first few inches of its movement; which, like the present ·550 bullet, would prevent its expanding so quickly as is desirable, from the pressure of the escaping gases on its sides.

That the condensed air in the barrel, has a powerful effect in resisting the motion of the bullet, and in expanding it, and even in altering the shape of its forepart, no one who has carried on experiments, in order to prove this, will deny; but it is only in the upper portion of the barrel.

That some bullets, from their peculiar form, are more easily expanded than others at starting, there cannot be any doubt; and such early expansion is particularly desirable, provided the bullet, from its form, is otherwise fitted for passing swiftly through the air. A solid plug of lead will expand sufficiently before it leaves the muzzle, but not so *quickly* as a bullet having thin edges; but then again, the thin edges should be protected by a cup, a plug, or a disc, to prevent them from collapsing. We have seen that the iron cups and wood plugs are not to be depended on for this purpose; but, with the discs, such as I have recommended, I have never known a single failure. That some bullets are thus more easily

expanded than others, and, therefore, more likely to be forced early into the grooves, may easily be proved, by those who cannot command a graduated compressing machine, in the following manner. Take an inflexible iron bar, of some 5 or 6 feet in length, and make one end of it fast like a hinge. Then place the bullet in a short piece of barrel of the same calibre, with an iron plug above it, under the bar, at about a foot from the hinge. At the other end certain weights should then be hung on, like a steel yard, beside an upright graduated scale, which would show, from the pressure or pulling down of the weights, the yielding, or giving of the lead. Those bullets which yield with the least weight, will, as a mere matter of course, expand with the least pressure of the gases, and, therefore, they will expand nearer to the breech of the barrel. The more solid the bullet, the further up the barrel will it be forced before it is sufficiently expanded into the grooves, unless its cylindrical part be of great length, which adds to the friction.

I have now, Gentlemen, to beg you will accompany me for a few moments to the Royal Arsenal at Woolwich.

Having arrived at the gates, we pass in, by permission of the authorities, and enter the Laboratory; the great centre—with regard to machinery—of all the great workshops there. In no other building in the world is to be found assembled together such a collection of machinery. The contents of the whole building, with its miles of lathe-bands, and thou-

sands of driving wheels, bewilder the mind by their incessant whirling, above, beneath, and around, as far as the eyes can reach on every side.

Four machines for making rifle bullets, first attract our attention. Coils of solid leaden piping are hung up in each machine. These they unwind, cut to the required lengths, stamp into the requisite forms, and then convey away into boxes provided for their reception. Each machine cuts, stamps, and thus passes away, 7,000 bullets, at an average, per hour; or nearly 300,000, for the four machines in a day.

No mode, whatever, of *casting* bullets can compete with these machines, with regard to expence; as the most costly compound can be turned out at an infinitely cheaper rate, than the most simple cast bullet. The wages, alone, for turning out 300,000 *cast* bullets per day, would amount to £3,000 per annum; without, at all, taking into consideration the many thousands which would have to be rejected by the scrutineers, and cast again, and perhaps again, before they were fit for service. While, on the other hand, the wages for turning out the same number of *compressed* bullets per day, would only amount to about £270 per annum. This, it must be evident, to all who have studied the subject, will always form an impassable barrier to any competition, other things being equal, between the simple cast, and the compressed compounds; and more especially, if in cases of emergency, the compounds, if required to be

cast, could be made to shoot fairly without their appendixes.

Bullets like the American, for instance, cannot be made correctly by machinery, unless of a very expensive description, in consequence of the grooves which surround the bullet and the hollow in the base. When Colonel Gordon's pamphlet arrived in America, the authorities there gave orders to have Mr. Pritchett's bullet tried with their "modified Minie," as the former could be made by machinery, though not the latter. But how did they try it? Why, by making a bullet which was no more like Mr. Pritchett's, than a circle is like an ellipse; and which was, moreover, a perfect libel on his bullet, as may be seen on looking at the diagrams. This might have been done through ignorance, or it might have been done through design, but it matters little whieh, for, as the shooting was, in consequence, reported inferior, it was no excuse for doing that which was a gross piece of injustice to Mr. Pritchett. But we must not be too hard on the Americans, for similar treatment has been too often the cause of public complaint in our own country.

From this digression, we now turn with interest to ten little machines which we find erected in the Laboratory for making box wood plugs, the subject matter of our present inquiry. These are fed with pieces of box wood, which are converted into plugs at the rate of 30,000 in nine hours, or nearly 300,000 per day for them all. We apply to Colonel Wilford for information, as to their intended use. He tells

us, that for three years he has been teaching his pupils, that they are "expanding agents" for rifle bullets. Feeling somewhat doubtful on this point, we turn to Colonel Dixon; but he shakes his head and intimates, that he thinks they are only useful in *protecting* the edges of the bullets from *collapsing*. In this dilemma, we appeal to the bullets themselves. They are dumb; but by signs which are far more intelligible than the most elaborate explanation of the "Minie" advocates, they declare, that Colonel Dixon is right, and that Colonel Wilford is wrong; but that only about a third of them do even the duty of "protectors"!

The more we examine the plug machinery, the more we are compelled to admire the ingenuity which Mr. Anderson has displayed in its construction; but as we continue to look, a feeling of sadness creeps over our spirits, as we reflect, that, as only a third of the plugs do any service whatever, consequently, out of every three machines two are working in vain. That out of every three men and boys, two are toiling in vain. That, on Saturdays, out of every three, two are paid in vain. That, in fact, out of every £3,000, the sum of £2,000 is literally thrown to the winds; and, to crown all, that out of all the millions which are made, *not one plug* does the *peculiar* duty which their inventors have assigned to them. These are facts which reflect little credit on the inventor of the plug, and which Colonel Wilford will have some difficulty in contradicting in a satisfactory manner.

In my first Lecture, I stated that, though not a first-rate marksman, I had repeatedly placed 70 per cent. of my bullets in a space the size of a man, at 600 yards distance. The truth of this statement Colonel Wilford has been pleased to question publicly, and also by leaving a written paper, to that effect, at the United Service Institution.

Now, Gentlemen, the statement which I then made was a simple fact, connected with the subject of my Lecture, and which, had I even dreamt of my veracity being called in question, I could have had certified by those who were present. The fact, however, was not stated as a boast of what I could do, but simply to show what the bullet could be made to do, even by my hands; for it would have been an easy matter for me to have named those, who, with the same weapons, could have beaten me out of the field.

As Colonel Wilford has, however, endeavoured, in a most gratuitous manner, to throw discredit on what I then stated, I now lay before you a certificate of shooting made by me at Enfield, in the presence of several members of the Small Arms Committee, of which Colonel Wilford himself was actually a member at the time.

This paper, as it states, is a Record of 40 shots from my rifle and bullet, at a range of 600 yards distance; fired by myself; direction of the wind, west, a light breeze. Thirty shots out of the 40 are put into a space of 3 feet by 5; but if the three outer shots are deducted, they may be said to be placed in a space, 1 foot 9 inches broad, by 4 feet high.

From this document it will be seen that I have placed 70 per cent. of these shots in a space not only the size of a man, but in a space so much smaller, that an ordinary sized man would have to kneel to fit into it—namely, a space 21 inches broad by four feet high, at 600 yards. I trust, therefore, that, whatever Colonel Wilford may be pleased to say on the subject, the Directors and Members of the United Service Institution, will acquit me of the slightest intention of wishing to impose upon them any thing having even the semblance of a false statement.

But, Gentlemen, there is something behind all this which is worthy of some serious consideration. When I fired my bullets at Enfield, the person who was employed there for such purposes, also fired some of the Service Ammunition, in order to compare it with mine. That his firing was inferior to mine, the diagrams made on that occasion, and the Books of the Committee, will show. Indeed, he acknowledged to me on the spot, that he could not make equal shooting with the Service bullets. And yet, in the face of these facts, Colonel Wilford, as one of that very Committee, sent in a report to Lord Panmure, on which the following letter was founded, and forwarded to me from the War Department.

"I have," says Mr. Drewry, "the commands of the Secretary of State for War, to inform you, that the Small Arms Committee, having examined the diagrams of comparative practice made at Enfield

between your Disc bullet and the bullet now adopted in the Service, find that, in accuracy, the Service bullet *has rather* the advantage; and that, as they do not see that your bullet has any advantages over the Service one, so far as its manufacture is concerned, they do not consider it necessary that any further experiments should be made with it.

With regard to "accuracy" the diagrams of shooting, made and recorded on that occasion, will speak for themselves. With respect to the "advantages in the manufacture." I have already shown, in my second Lecture, that had my bullet been even then adopted, a saving of £30,000 or £7,700 per annum, would have been effected by this time. How long this uncalled for expense is to go on it is difficult to say!

On the occasion referred to, I used my bullets in what is technically called, a naked state; that is, without paper or patch of any kind; the bullets being simply dipped in a mixture of bees wax, soft soap, and hogs-lard. This naked plan cannot be adopted with the wood-plug bullets; as the plugs would be shaken out of their places in the transport, if not held in, as they now are, by the paper which is choked and folded round them.

The powder I kept separately in the flask which now lies on the table, one of my own contrivance, but which Colonel Wilford, in his paper, affects to treat with some degree of contempt.

I, at that time, took the liberty of recommending the powder flask for special Corps; but, for regi-

ments of the line, I pointed out a very simple method of making a cartridge somewhat similar to Mr. Wilkinson's plan of 1852, but with the bullet and powder enclosed under the same outside wrapper, a plan which is now adopted in the American Service. Indeed, if the system of giving a preference to foreign inventions, over those of native growth, were ever again to be in the ascendency, we might possibly see this very plan imported from America, under some new name; though the bullet, it will be seen on looking at the diagrams, is but a cousin-german of the French "Minie." This, however, I must do the American authorities the justice to say, they admit; for instead of a deep cavity, and an iron cup, the American bullet has simply a conical cavity, and a sharp point; which they have the honesty to call the "modified Minie" instead of adopting it as a new invention of their own."

It has been said, that my bullets have long been before the War Department, and have been tried without decisive results both at Enfield and Hythe. This is quite true; they have been long—very long, indeed, before that department; but I assert, most positively, that the total number of bullets which have been fired, at both places, has not exceeded *one hundred and twenty*. Then how, I ask, could there have been any decisive results, or any trial which could possibly have warranted a report being sent in? That report, it will have been remarked, ends with saying, that "they do not consider it necessary that any further experiments should be

made with my bullets." I had then only fired, in all, about 60 rounds, it may therefore, be easily seen, that that report was, no doubt, meant to put an end entirely to any further competition or interference on my part. I am, however, happy to say, that, in spite of all the opposition which I have had to contend with, and the difficulties which have been thrown in my way, the present Secretary of State for War has decided that my bullets are yet to have a fair and full trial against all comers. This is all I ask, and all I have ever asked, and I have every reason now to hope and believe, that, with a view to the encouragement of native talent, the new Committee will be actuated by those feelings of impartiality and fair play, which are so eminently the boast of every true-hearted Englishman.

In reverting to the principal object of this Lecture, I may remark, in conclusion, that the theory of the "Minie" cup, and now of the wood plug, has been a settled doctrine, with many, for nearly ten years. It has very generally been deemed an established truth, and has, consequently, passed away from examination, as that which need not again be questioned. It is spoken of as an ascertained fact; and its discovery and extended application has been considered great achievements. In fact, it has been so intimately associated with the science of gunnery, in all its ramifications, that it is now almost impossible to bring the minds of some men to its re-examination. Under these circumstances, we have certainly less cause to wonder,

that the attempt to substitute another theory, to assign other laws of expansion, should be deemed, by its patrons, the wandering of an erratic mind, or the presumption of an ignorant man.

The more closely, however, that we study the system itself, and consider the opinions of those who patronize it, the more clearly we can discern its errors; and, moreover, that two different casts of mind have been engaged in their promulgation. One giving greater, the other less attention to facts ; the one the more rigid and exact in observation, the other the more prone to speculation. Hence the perpetual conflict between the practical and the theoretical. But the dispute concerning their values is in words merely ; for theories unsupported by facts, and an accumulation of facts without reference to the laws of their combination, are equally worthless, The learner depends upon the teacher for the formation of his mind, and the establishment of his principles; the man, therefore, who only knows facts, and the man who, ignorant of the doings of nature, dreams rather than judges, are both equally unfit for instructors.

I have endeavoured to present to you a view of the subject, which appears to me to be supported both by the laws of nature and observation; and I feel confident, that, however defective may be my logic—however imperfect may be my statement of the facts of science.—however crude may be my application of the truth to the explanation of the phenomena, I have unfolded to you facts and princi-

ples, which, when distinctly evolved from the errors of the day, will change entirely the belief in the "Minie" System, and the mechanical philosophy on which it is founded.

To induce reflection upon a questionable though acknowledged theory, cannot fail, I humbly trust, to do some little service to the cause of truth; for, as it has been observed, "nothing tends more to the corruption of science than to suffer it to stagnate. The waters must be troubled before they can exert their healing virtues." Men are too often taught to believe rather than to reflect,—to receive opinions rather than to unfold them by the process of careful examination. It is thus, that theories pass from mind to mind, from generation to generation, as settled truths; and theories too, which are not only questionable, but are indistinctly comprehended, even by those who teach them.